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A CITY WITHOUT WATER

SCIENTIFIC AMERICAN

A Weekly Review of Progress in

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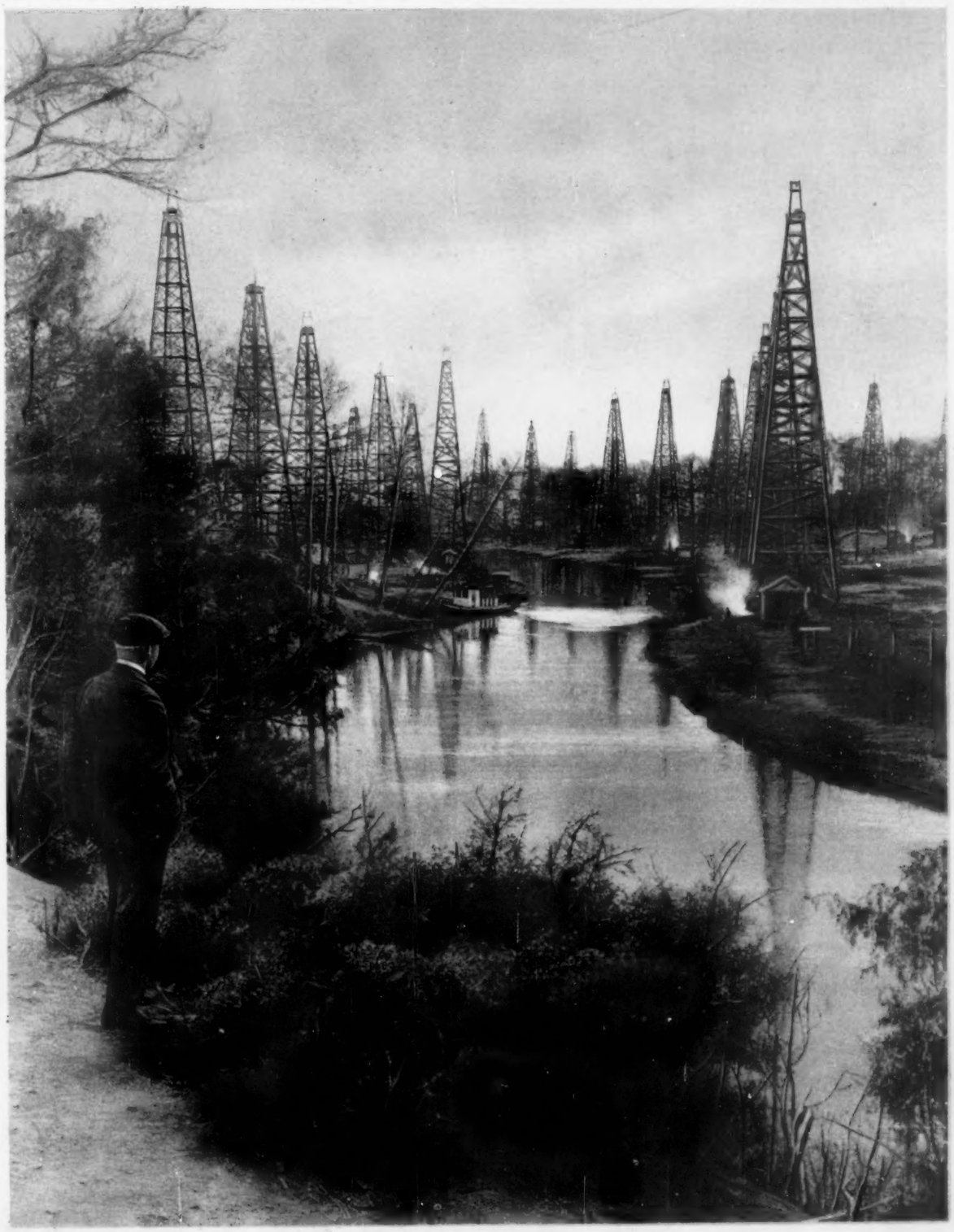

POWER FOR THE AUTOMOTIVE WORLD: OIL WELLS OF OUR GREAT SOUTHWEST

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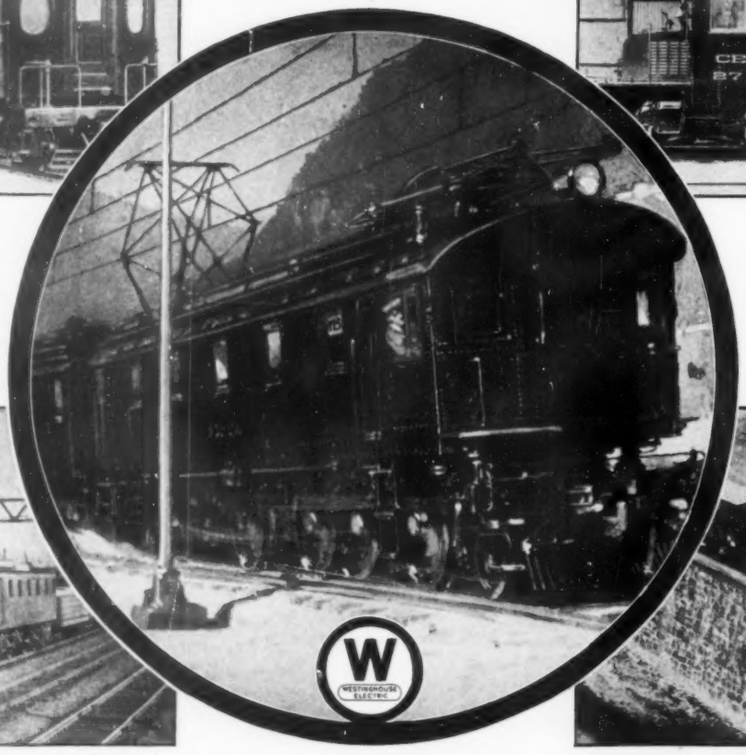

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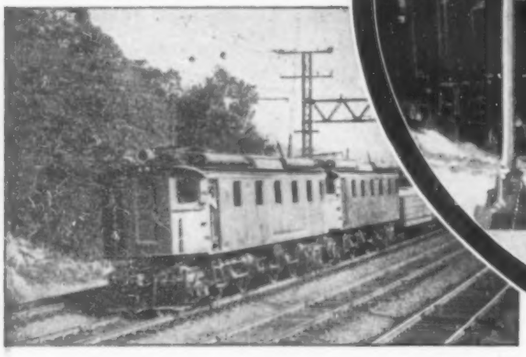
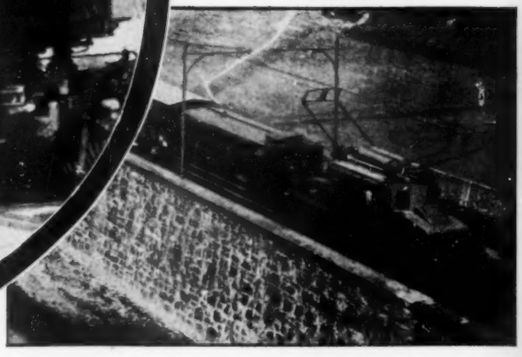


Italian State Railways



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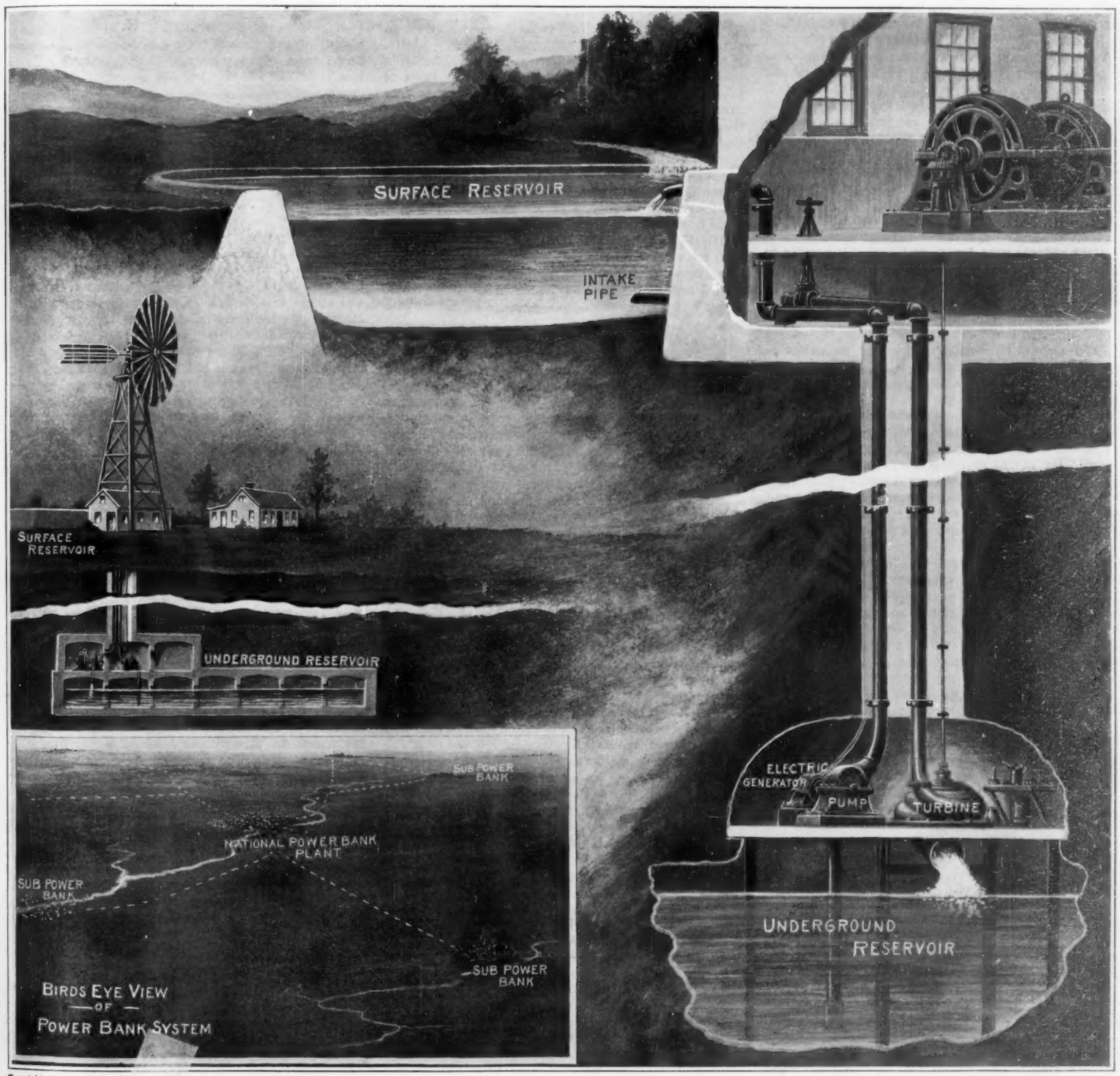

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PROFESSOR REGINALD A. FESSENDEN'S POWER BANK SCHEME: A COMBINATION OF WATER STORAGE AT VARIOUS POINTS WITH AN EXTENSIVE TRANSMISSION LINE NETWORK FOR REDUCING THE COST OF ELECTRIC CURRENT—(See page 348)

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Phantom Ships

THE propaganda for driving the United States into the construction of a navy larger and more costly than the present world conditions demand has resorted to many half-statements and positive misstatements which cannot be too quickly nailed down and refuted. Prominent among these has been the announcement that Great Britain is building for Japan several huge warships greater than anything yet designed. The inference, which the sponsors for this untruth were hoping that Congress would draw, was the obvious one that England's good faith in stopping warship construction and cutting down her navy was questionable, since the building of many big warships for her ally, Japan, was tantamount, in the event of hostilities, to building them for herself.

The most interesting fact about this statement is that it is absolutely untrue. Great Britain has no military alliance with Japan, so far as this country is concerned, the United States having been expressly exempted as a possible enemy; and furthermore, Great Britain is not building a single capital ship, either for herself or any other power. This we have ascertained through our London correspondent whom we asked to make a thorough investigation. He writes us that no capital ship of any kind is at present building or completing in the United Kingdom, either to British or foreign order; nor has the keel of a warship of any description been laid to foreign order since the armistice. He tells us that, after spending some time in investigating these rumors, he found that the only grain of truth lay in the fact that the following contracts have been placed by the Japanese Government, namely: an order for some special curved armor for ships and for some sets of Diesel engines for submarines from Vickers, Limited, and an order for armor-piercing shell from Hadfields, Limited. This, he informs us, is the sum total of work being executed in the United Kingdom on behalf of the Japanese navy.

In an interview with Captain S. Kobayashi, the Japanese Naval Attaché in London, he learned that there was practically no possibility of warship orders being placed abroad, owing to the fact that the Japanese shipyards were very short of work and were therefore most anxious to secure any orders which might be available. Hence, the Attaché thought that the Japanese Government would not contemplate placing orders for warships in a foreign country.

Referring to certain criticisms which have been made in regard to the departure of British airmen for Japan, our correspondent informs us that these men are going, not as a part of a special mission, but simply as private individuals. They are nearly all ex-officers of the Royal Air Service, whom demobilization has left without a job, and they are naturally eager to accept employment in the flying line wherever it can be found.

So much for this mare's nest, which is typical of much of the altogether vicious and designedly misleading propaganda which is being prosecuted, not in the interest of peace, but in the endeavor to stir up suspicion between great peoples, whom the stress of the great war has brought into relations of mutual confidence and respect.

Measuring Impact Effects on Roads

THE need for strengthening county bridges to withstand the impact of heavy vehicles was recently discussed in these columns. The importance of the question is equaled only by the neglect with which it has been treated. Only of late years, indeed, has the magnitude of impact stresses begun to be appreciated both by the road and bridge builder, and hence the report on this subject by the United States Bureau of Public Roads, which has just been made public, is very timely. The report deals with a series of experiments which has been carried on at Arlington, near Washington, D. C., for the past two years. Although the complete deductions to be drawn from the tests have not been made, sufficient data have been developed to show that the magnitude of the impact of wheels upon the road surface is very closely related to the tire equipment.

Of course, any analytical mind that gave even a passing thought to the question realized that there was a wide difference between the static pressure upon a roadway of the wheels of a motor truck when it was standing still and the impact effect, in the form of a succession of blows, when the same wheels were passing swiftly over a road of uneven surface. It will surprise many drivers of motor trucks to learn that if the solid-rubber-tired rear wheel of a motor truck which is traveling at 16 miles an hour encounters an obstacle that stands only one inch above the roadway, it will strike a blow whose vertical effect will be seven times the load on that wheel. On the other hand, if pneumatic tires be used, the average impact is only from 1¼ to 1¾ times the wheel load. The moral of these results, as far as the truck is concerned, is to show the value of the pneumatic tire in reducing wracking effects on the machine itself. So far as the roadway is concerned, the tests, as thus far developed, preach the lesson of eternal vigilance in making quick repairs of any depression or breaks in the roadway; for it is obvious that as the depth of a hole is increased by the traffic, the impact effect will grow in proportion. Well might President Harding, in his address to Congress, deplore the fact that millions of dollars are expended in building good roads, and quickly lost again by neglecting to maintain these roads in good condition.

Train Speeds and Track Costs

APROPOS of the question of impact effects of motor-truck wheels on highways, we note that the American Railway Engineering Association has issued a report on the effect of increased speed in raising the cost of track maintenance, in which the fact is brought out that there is an increase in the cost of maintaining the track of 0.5 per cent for each increase of a mile per hour in the speed of freight trains.

No doubt, it is popularly supposed that because the steel rails of a well-laid track present such a smooth, even surface to the eye, impact effects due to irregularities of surface are unknown. As a matter of fact, the average railroad track is not as perfectly true in surface as it would appear to be, and because of the varying degree of elasticity in the ties and roadbed, there are frequent relatively hard spots, which have the effect of inducing heavy vertical impacts from the concentrated wheel loads of the train. Furthermore, there are the lateral impacts, due to the nosing of the engine and cars and to the surging of the train on passing around curves that are not of perfectly even curvature.

In a general way it may be said that impact effects will vary as the square of the velocity, and hence will produce a proportional increase in the wear of the track and the cost of the labor, tools and materials necessary to keep the track up to a given standard. An analysis as given in the *Engineering News-Record*, supposes an increase in the average speed of freight trains from 20 to 25 miles per hour over a road of 75 per cent tangent and 25 per cent curves. The increase in maintenance expenses in such a case works out at about 2.4 per cent, which for freight service gives a rate of 0.5 per cent per mile per hour increase.

Progress in Our Army Ordnance

THE lessons of the Great War have been turned to good account by our Army Ordnance. The country will be glad to know that its ordnance experts have sifted out and translated into improved ordnance the lessons of war, and that they are producing new weapons which are superior—greatly superior—even to the fine weapons with which the war was fought. Take for instance the famous French 155 mm. mobile gun, which formed, with the 75 mm., the principal artillery of our American army at the front. This is a justly famous weapon, designed by the French, which contributed greatly to the success of the Allies. The gun, which is of practically six inches caliber, has the wide angle of traverse of 60 degrees, and a maximum elevation of 35 degrees. At this elevation, with a muzzle velocity of 2,380 feet per second, the shell was thrown to an extreme range of 17,700 yards. The gun has a length of 38 calibers. Army Ordnance has produced, since the war, an improved 155 mm. gun and carriage. The gun has been increased in length from 38 to 45 calibers, the muzzle velocity has gone up from 2,380 to 2,800 feet per second, and the carriage has been so designed as to admit of a maximum elevation of 65 degrees. At this elevation and velocity the maximum range is 26,000 yards, or about five miles greater than that of the French model of 1918. An 8-inch howitzer carriage has also been designed, which at 65 degrees elevation gives a maximum range of 18,000 yards. It is gratifying to note that with the exception of the gun, whose weight has been increased from 8,800 to 9,200 pounds, there is a decrease in the weight of the new weapon, the weight of material in firing position having been reduced from 25,900 pounds to 24,000 pounds and the weight of the gun carriage and limber, complete, from 29,400 pounds to 28,000 pounds, while the weight of the maximum load when traveling has been reduced from 25,400 pounds to 17,000 pounds. Army Ordnance is to be congratulated upon these excellent results.

In Justice to the Army Air Service

THE American people have no wish to be unjust, and therefore they will welcome any opportunity to correct an unjust charge. Frequently during the war, and since, we have heard the statement that the Government spent over a billion dollars for aircraft and "had nothing to show for it." Now, we have no intention to stand as apologists for the many and serious mistakes which were made in our wartime aircraft effort. These mistakes are frankly acknowledged by the authorities themselves; but the statement that we spent a billion dollars for nothing is doubly untrue; first, because the actual expenditure during the war in our aeronautical endeavor was exactly $598,090,781; and secondly, because for that money we secured nearly 20,000 machines, trained a great army of fliers, and placed a large force both of machines and men in the war zone before the signing of the armistice.

These facts have been compiled by the *Aviation and Aircraft Journal* from the official report of the Liquidation Division of the United States Air Service, and are published in the issue of April 18th. The Liquidation Report shows that the actual amounts appropriated for the Army Air Service during the war aggregated $1,687,054,758. From this total amount, there were revoked by Congress sums aggregating $487,000,000, so that the net amount available for expenditure by the War Department was $1,200,054,758. It is now revealed that out of the amount available for expenditure, no less a sum than $582,564,781 has been returned to the United States Treasury. So much for the "wasted billion dollars."

Now, as to the actual production and work accomplished. In round numbers the amount spent for army airplanes in the United States was 114 million dollars, for which the Government received 13,894 American-built airplanes. The Government spent abroad the sum of 139 million dollars for training and for the purchase of airplanes, engines, construction of cantonments and production centers, and received, among other equipment, 5,198 complete airplanes, making a total of 19,092 airplanes produced in the United States in a period of 21 months, which exceeds the production of any other country for a like period. At the signing of the armistice, in addition to the 5,198 airplanes purchased abroad, 2,091 American-built seaplanes had been shipped to France, and 1,040 were either at points of embarkation or were in transit. Of these, 1,444 had been actually received in France, of which 667 American-made machines were in service at the front.

Let us be fair. We started the war with nothing. We had to create three times; an airplane industry, a fleet of airplanes, and a force of trained pilots. At the armistice we had a huge well-organized industry; nearly 20,000 airplanes; and a whole army of carefully selected and thoroughly trained fliers. The novelty and magnitude of the task and the speed with which it was accomplished render the total cost of 590 million dollars not unreasonable.

Engineering

A Long Aerial Tramway.—Contract for an aerial tramway from the Premier mine in British Columbia to tidewater has been awarded to a Spokane company. The line will be nearly twelve miles long, with a drop of about 120 feet to the mile. The tram line, bunkers, and unloading devices will cost a quarter of a million dollars.

Ocean Sewage Disposal.—The State Department of Health of New Jersey has been conducting a serious investigation to determine the effect that the discharge of sewage into the ocean has upon the quality of water at bathing beaches. The results indicate that effluent travels approximately parallel to the shore, and in a very narrow stream; that the ocean water rapidly dilutes or oxidizes the effluent; that the surface film of effluent ultimately reaches the surf but only after such great dilution that it is of a higher bacterial standard than surf water where there are numerous bathers.

Concreting a Railroad Tunnel.—The Canadian Pacific Railway is concreting the five-mile Connaught Tunnel near Glacier, British Columbia. This tunnel is through solid rock and although this material would be supposed to be of the most lasting character, a lining of concrete is being placed against the rock to make assurance doubly sure for a clear and safe roadway for the trains. This difficult work is being done without interference to the operation of traffic. The smoke from the trains is blown out of the tunnel by giant fans set in motion after a train passes, and it only takes a few moments to clear the air the entire length of the tunnel.

Facing Buildings with Pottery.—In a recent lecture before an English gathering Prof. Beresford Pite discussed the possibilities of ceramic products in the clothing of reinforced concrete skeleton buildings. Unlike many architects who regard traditional practice as something quite sacred, Professor Pite would throw the conventions of the past to the winds in order to meet modern developments. While admitting the structural advantages of reinforced concrete, he is not an admirer of concrete as a material for exterior surfaces, and advocates the clothing of the structural skeleton with "a garment of permanent, effective, beautiful, ceramic color, unlimited in its variety and worth."

Road Construction in China.—The Central Government of China is evincing considerable interest in road building, and the Ministry of the Interior, which has charge of highway projects in conjunction with provincial officials, is said to have prepared a bill concerning highway development for presentation to the new Parliament, which is expected to meet in Peking at an early date. Considerable road construction is being conducted in connection with the famine relief work whereby the recipients of relief are enabled to render compensation for the food furnished them and thus contribute to the permanent betterment of China's transportation facilities, which will tend to minimize such catastrophes in the future.

A Mold for Measuring Rail Wear.—The old-fashioned method of ascertaining the extent to which a rail has been worn under traffic by taking it out of the road and weighing it, is now superseded by taking a mold of the rail and calculating the weight from a tracing of the cast. The first material used for this purpose was plaster of paris, but this was found to be unsatisfactory owing to its irregular contraction. A British engineer has now introduced the use of plasticine, according to *Engineer*, for the making of the mold, and has patented a simple form of nut-cracker apparatus for rapidly taking rail molds in plasticine. The mold is placed with a piece of sensitized paper behind it in a printing frame and the area of the photograph produced is taken out with a planimeter, and the weight of the rail calculated.

Pre-cast Concrete Roads.—Owing to the impossibility of finding suitable aggregates, or even the provision of the necessary water for concrete-making, along the route taken by a new high road under construction from Casper to Salt Creek, Wyoming, it has been necessary to establish a casting plant at Casper, where these are available, and to transport the finished slabs a considerable distance before laying, says the *Technical Review*. About six miles have already been covered with slabs 16 feet wide and of an average thickness of 6½ inches; and if the scheme proves generally successful, a further 40 miles will be laid to form a roadway of a present width of 9 feet. The slabs are of reinforced concrete, the purpose of the reinforcement being merely to strengthen the slab for the purpose of lifting and hauling to site. The finished slabs weigh 6,300 lbs. each and are cured for 30 days under proper conditions.

Science

Dolphin Steak a la Russe.—The use of the flesh of dolphins for human food has proved successful. A Moscow despatch reports that steps are being taken to establish a dolphin fishing industry.

Helium for Divers.—The suggestion is put forward by the *Chemical Trades Journal* that if a mixture of helium and oxygen were supplied to divers it might considerably lengthen the time they could remain under water, on account of the increased rate of expulsion of carbon dioxide from the lungs which would be produced.

A Huge Emerald.—An uncut emerald weighing 630 carats has recently been brought to this country for dividing and cutting, as of course it would not be marketable in its present form. There are larger emeralds in existence; one in Bogota weighs 1,000 carats, and one of the Russian crown jewels, before their dispersion, weighed 6¾ pounds.

The Zoo and the Aquarium Top the List.—The New York Zoological Park, referred to by the vulgar as the "Bronx Zoo" very much to the Director's ire, had 2,150,177 visitors during 1920 and the more conveniently situated Aquarium at the Battery had 1,994,548 visitors. This is the largest popular following of any organization in the world for the New York Zoological Society operates both enterprises.

Raising the "Yak" in Alaska.—The "yak", or woolly ox of Thibet, is soon to be transplanted into Alaska and the Canadian northwest by Dawson men. For centuries the yak has been domesticated by man and its haunts are the snowy highlands of Thibet, 20,000 feet above the sea. Its native food is coarse wiry grass, but it will eat anything that cattle will. In size it compares favorably with range cattle—1,000 to 1,200 pounds. The meat is as delicious as beef, and the wool and hide are valuable.

Reindeer Meat for All.—Reindeer meat is one of the solutions of the ever-present beef, lamb, mutton and pork problem. Reindeer are multiplying much faster than the needs of Alaska require. A company has established a plant at Nome for handling twelve thousand carcasses a year. The meat can be sold profitably even though the freight rate is $140 a ton to Minneapolis. The dressed carcass weighs about 150 pounds, but this could be increased to 300 pounds by crossbreeding with the caribou, a heavier animal.

Bulgarian Surgeons Adopt Stone Age Methods.—Stone Age tools are being used in Bulgarian hospitals to perform surgical operations. In the absence of any steel instruments whatever with which to operate, the Russian surgeons in charge have taken a leaf from the book of their prehistoric ancestors, and have used chipped flints. Moreover a freshly chipped flint has an excellent cutting edge and possesses perfect immunity from infection. So crude but thoroughly septic operations are being performed with flint knives.

Summer Furs Exterminating Animal Life.—Prof. Osborn has made a plea for women to cease wearing so-called "summer furs." He said wild animals are being destroyed so rapidly that in thirty years there will be practically none left and the next generation will have to go to a zoological park or look at paintings or photographs for a knowledge of wild animals. Professor Osborn is an exceedingly careful writer and speaker and his warning is amply justified, the senseless wearing of furs in summer should be abandoned.

Trying to Save the Elk.—The elk are in danger of extermination, 10,000 head supposed to be in the Yellowstone having disappeared. This seems to be caused by cattle men grazing their herds on areas formerly occupied by the elk, which perish in great numbers when they find their old pastures denuded. Ranchmen in many cases have fed them hay out of pity and the Federal authorities have bought and stored hay in the hope of preserving the breed. Cattle men are not much interested by these splendid examples of animal life so that the Government should do something on a large scale to preserve them.

Alloy Research.—The National Research Council announces that an Alloys Research Association has been formed, the primary object of which is to furnish "An informational service concerned with metals and their alloys." It proposes to supply, to those applying for it, information as to current literature, discoveries, etc., and references and abstracts of all known information upon a given subject. This is of interest to mineralogists and crystallographers because many of the properties of metals are related to their crystal structure (although this is not mentioned in a list of over 40 properties and phenomena which the Association has tabulated as important).

Electricity

National Electrical Safety Code.—Handbook No. 3 of the Bureau of Standards has recently been published and may be obtained from the Superintendent of Documents, price 40 cents. This new edition is a book of pocket size and the discussion of the rules has been segregated in a separate volume, which will appear later as Handbook No. 4.

Telephoning 5,700 Miles.—Another technical triumph for the engineers of the American Telephone and Telegraph Company was scored on April 11th last, when President Harding of the United States and President Menocal of Cuba formally opened telephonic communication between Cuba and Washington, and immediately afterward messages were sent from the Catalina Islands, off the coast of California, to the Cuban President at Havana, a distance of 5,700 miles. The radio telephone, land lines and cables were used to span the intervening distance.

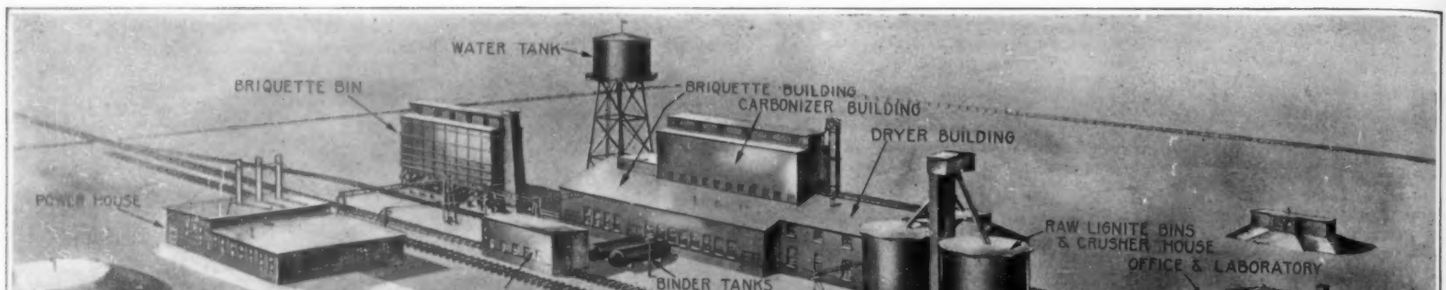
Fused Silica Valves for Radio.—From the English *Electrician* we learn that considerable progress is being made in the construction of "valves" for handling large outputs by H. M. Signal School, at Portsmouth. Patents have been taken out by the Admiralty for the construction of vacuum tubes in fused silica which has made possible the handling of larger outputs. It is believed that considerable ranges have already been effected with silica valves, and that there seems no doubt that if the present progress is maintained the silica valve may ultimately supply the best solution to high power stations.

A Telephone Receiver of the high resistance type may be used for testing high voltage insulators while the line is in service, according to an authority writing in *Electrical Review*. This test is used mainly on lines using pin-type insulators, as it is of less value with suspension-type insulators. One terminal of the telephone circuit is mounted on an exploring rod and may be brought near to, or actually in contact with, the transmission line pole at a considerable height above the ground. The other terminal is grounded. If there are leakage alternating currents of appreciable magnitude flowing in the pole a peculiar crackling noise is heard in the telephone receiver, but if all the insulators are in good condition nothing but a musical hum will be heard.

Improved Beads for Insulation.—In certain installations, such as radio equipment, arc lamp wiring, and laboratory apparatus, it is often necessary to resort to beads for insulating bare wires. Heretofore the beads have been of a plain design, with rounded ends, resulting in a rigid covering which prevented the covered wire from being bent as desired, or left bared sections of the wire between the beads because fewer beads had to be strung in order to allow for bending. An English concern has recently introduced a new type of bead which is rounded at one end and hollowed out at the other, thus permitting of one bead fitting into the hollow of the next bead. These beads permit of covering a wire for its full length, yet do not interfere with the bending of said wire.

Testing Porcelain Insulators for Cracking.—Electrical puncture may be what puts a particular unit of a transmission line out of service, but this is not due directly to an excessive voltage gradient in the material of the insulator. It is frequently brought about by the unequal expansion of the hardware and the porcelain to which it is cemented, which develops small cracks and starts the trouble. The porcelain itself should be of a kind which will resist sudden changes of temperature. It is now manufactured to withstand alternate immersions in boiling and freezing water without developing cracks, and porcelain bodies have actually been made which can stand being brought to a red heat and then plunged into ice water, without developing cracks.

The Arc System in Radio.—Advocates of the arc system of radio communication claim that theirs is the best method for unfailing, regular communication by radio over long distances. Generating continuous waves, the arc system has all the advantages of: Maximum power input to a given aerial system, enabling a cheaper and smaller aerial system to be employed to transmit over a given distance, or increase of range of an existing station by substitution in place of a damped wave generator. Greater selectivity in reception with consequent greater freedom from interference and atmospherics, thus rendering the service less liable to interruption. Heterodyne reception, giving improved signal strength and choice of audio-frequency to suit the operator with still further freedom from interruption.



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The Canadian carbonizing and briqueting plant now building at Bienfait, Sask., in the heart of the lignite district

American Lignite Coals

Canada Blazes the Way to Put Them on a Par with Anthracite

By Robert G. Skerrett

CANADA'S fuel problem has brought about action on the part of the Dominion Government that is no less important to us than it is prospectively to our northern neighbors. The work of the Lignite Utilization Board of Canada will shortly bear fruit through the carbonizing and briqueting plant now rapidly nearing completion near Bienfait in the Province of Saskatchewan, just across the boundary line of North Dakota. The establishment is designed to have an annual capacity of 30,000 tons of lignite briquets, costing, loaded on cars, about $7.50 a ton at the works. Each ton of this fuel, as amply demonstrated, will have, when burned in the domestic furnace, substantially the heating value of an equivalent unit of anthracite coal. Two tons of lignite will make a ton of briquets.

While the fuel resources of Canada are both great and varied, their geographical distribution unfortunately leaves a vast region, lying between the bituminous coal deposits in the neighborhood of the Atlantic Coast and the lignite beds of Saskatchewan, destitute of natural fuels save such as peat and wood. The coalless industrial districts of Quebec and Ontario are in this unfavored area, and, accordingly, these provinces, together with Manitoba, must in the main obtain their coal from the United States. This situation has not unreasonably been viewed by the Dominion Government as "an industrial menace and a national problem," hence the steps that have been taken to turn the native lignites into a really efficient fuel.

Up to now, the fuel question in western Canada and particularly in Saskatchewan has bristled with physical and economic difficulties. Into that region there has gone annually in normal times, from the anthracite mines of Pennsylvania, quite 500,000 tons of coal, representing to the consumers an outlay of about $6,000,000. In addition to this fuel, so it seems, householders have used large quantities of the native coal owing to its cheapness; but the stuff is dirty, breaks up easily, and disintegrates quickly. In short, it is objectionable in use, and relatively low in heating value.

However, underlying the Province of Saskatchewan and reaching southward into Montana, Wyoming, and the Dakotas are immense deposits of poor lignites. These beds cover more than 13,000 square miles, and are estimated to hold 59,812,000,000 tons of the fuel. The lower seam of these lignites is deemed commercially the more important, for it attains a thickness of eight feet, yielding 11,000 tons an acre, or substantially 10,000,000 tons to the square mile. Better lignites and bituminous coals occur in Alberta; but for economic reasons, the Canadian authorities very sensibly set themselves the task of finding a process by which the Saskatchewan lignites could be made nearly comparable with anthracite—realizing that if they achieved this they would incidentally have at hand the means by which to briquet the higher-grade lignites of Alberta.

At the very start, the Lignite Utilization Board availed itself of all information obtainable in the United States and in Europe, and then bent its energies to dealing with the circumstances immediately confronting them, seeking the while to employ to advantage any domestic media that would be likely to keep down the briqueting cost. After the examination of a large number of samples of Saskatchewan lignites, the average composition was found to be as follows:

Moisture	26.13
Volatile hydrocarbons	28.11
Fixed carbon	38.16
Ash	6.86
Sulfur	0.74

The mean of the products of carbonization of a ton of these lignites was:

Gas	10,000 cubic feet
Oil or tar, waterfree	15 gallons
Ammoniacal liquor	65 gallons
Carbon residue	955 pounds

Experience has shown that lignite carbonizes much more readily than bituminous coal. This confirms the investigations of our own Bureau of Mines, which discovered that lignite does not coke in the sense that bituminous coal cokes, but crumbles on being carbonized. This action facilitates a continuous and a comparatively inexpensive distilling process, and obviates the laborious and costly charging and drawing of retorts as practised in coal-gas plants. Further, lignite parts with its volatile content more readily than is the case with bituminous coal. The most rapid evolution of gas takes place at the comparatively low temperatures of from 700 to 900 degrees Fahrenheit; and substantially all of the gas is released when 1,000 degrees is reached. The gas has a heating value of 400 to 450 British thermal units to the cubic foot.

According to the Report of the Canadian Research Council, there is more gas in a ton of lignite than would be required to carbonize another ton of the raw material. Assuming that it takes 6,000 feet of gas to carbonize a ton of lignite, each ton undergoing treatment would then supply an excess of 4,000 cubic feet which could be used for other purposes, among these the generation of power. Inasmuch as the average gas engine consumes 10,000 B.t.u.'s per hour per horsepower, 4,000 cubic feet of the gas would supply motive energy for 160 horsepower-hours. The ammonia by-product of the carbonizing process can be made available as a fertilizer, for use in refrigeration, or as an ingredient in the manufacture of explosives; while the oils and tars, resulting from the distillation of the lignite, have many fields of application. The Lignite Utilization Board, however has centered its efforts upon developing a satisfactory briqueted fuel primarily for domestic consumption. The Canadian authorities have watched with alarm the steady upward trend of the price of coal obtained from this country, and they sensibly are seeking to anticipate the day when the United States will, in all likelihood, place an embargo upon the exporting of anthracite. As they figure it, the cost of lignite briquets will drop with greater production, and the use of that fuel will widen directly in proportion to the volume of output.

IN a recent issue, Mr. Skerrett told us something about the brown coals of Germany and the success with which they are being utilized in a manner that puts them right on a par with anthracite. There is something fascinating in this idea of taking deposits that if left to themselves would become hard coal a few million years from now, and in a few hours converting them into the fuel equivalent of hard coal. In a sense the processes of geologic ages are accelerated so that they are brought to their conclusion in hours or even minutes. And now we learn that what has been done in Germany is being done in Canada and may be done in the United States, with the enormous deposits of low-grade coal existing in the great Northwest.—THE EDITOR.

The plant at Bienfait is the climax of carbonization experiments which have passed successively through small-scale laboratory tests, large-scale laboratory tests, and semi-commercial tests; and thus the Fuel Utilization Board has reached the conclusions which have warranted the Provincial Governments of Manitoba and Saskatchewan and the Dominion of Canada in appropriating a total of $400,000, of which fully $370,000 will be expended in rearing and equipping the works. This is a tidy sum, but the outlay will soon justify itself. With the briquets bringing $7.50 a ton at the factory, the transportational charge amounting to $1.50 within a radius of 150 miles, and allowing another $1.50 for a dealer's profit and cost of delivery, the ultimate consumer would then pay but $10.50 a ton as against something like $15 now asked in that region for Pennsylvania anthracite. This represents a potential saving of certainly $4 a ton; and with a plant output of 30,000 tons yearly, the householders would be the better off each twelvemonth by $120,000. Further, viewing the matter from its broader economic aspect, the Dominion would keep within its boundaries annually $450,000, while laying the foundation for a domestic business susceptible of tremendous expansion.

Much like the brown coal of Germany, the lignite of Saskatchewan is so deficient in inherent binding material that a briquet made without the addition of a

(*Continued on page 355*)

Recruits for the World's Biggest Fish Show

By James Anderson

NO one thinks of visiting New York without taking in the Aquarium, and these visitors can testify to the fact that the unique job of acquainting Americans with the fish that swim in the waters of the new world is well done. But the question naturally arises in the minds of the six thousand-odd persons, from all parts of the world, who daily go there to pay their respects to Mr. Fish—how are the multitude of living specimens procured?

This is an important feature of the business of the Aquarium, not only constantly to put on what is positively the greatest fish exhibit on earth, but to recruit the cast of performers in the show. Devious means of procuring the specimens have been tried, including exchange and purchase, but the best method has only recently been put into effect.

Realizing that its collection, great as it is, is by no means complete and that there are still just as many interesting, rare, curious, and freak fish in the sea as ever were caught or displayed in the Aquarium, its management has gone into the sport of fishing on a larger scale than ever before. The Aquarium is now equipped with its own fishing boat, which shoves off once a week from its New York dock and returns loaded down with thousands of additional specimens of the finny clan.

This supply ship, christened "The Seahorse," is unique among fishing craft. Instead of going out to catch fish for food, with hook and line, it hunts them in nets; and the greatest possible care is taken not to injure the catch but to keep them alive and well. To do this the "Seahorse" is separated amidships by water-tight bulkheads from the fore and after sections. The middle section is similar to a well, and is provided with a constant change of sea water through many holes bored in the hull. The well is 11 by 10 feet at the bottom, of such goodly size that the fishermen are enabled to land alive in New York anything which they may catch.

The "Seahorse" is not a big boat as fishcraft go, being only thirty-five feet in length over all; but she is thoroughly seaworthy and most scientifically arranged. For power she uses a two-cylinder, four-cycle Frisbie engine, and in case this should break down, she is equipped with a suit of sails.

This boat has been in operation only since June but has already proved its value, having been the medium of bringing additional hundreds of the finny tribe into the tanks of New York's gigantic fish show. Already she has made about twenty trips to sea, returning with a total of about 18,000 fish. The trips are made about once a week and each jaunt is of approximately twenty-four hours' diversion, the boat going quite a distance out past the fishing banks, the mecca for fishermen from the metropolis. On its autumnal trips it has been able to get more interesting and valuable specimens than was possible early in the summer due to the fact that during the latter part of August and early September many odd specimens of the finny tribe come northward from tropical seas.

Ponder for a moment, you amateur wielders of the rod, and think of this day's catch of the crew of the "Seashore": 1 cow-nosed ray, 9 dogfish, 20 weakfish, 40 puffers, 4 daylight flounders, 3 sea robins, 3 blackfish, 10 young mackerel, 20 spots, 12 crockers, 11 fluke, 2 bluefish, 1 sand shark, 2 lobsters, 20 rock crabs, and 6 king crabs. Many of them are of course ordinary, but the "Seahorse" has just started; and what bait slinger would not be satisfied with such a catch?

The Aquarium has put is own fishermen to work at a most opportune time as due to various reasons it is now dependent almost entirely on the boat for additional members to the cast of the great fish show. This has come about because neither railroads nor steamships have, due to freight congestion, found it possible to stock its tanks with new fish as in other years. Also many of the boats which formerly brought fish to the Aquarium have experienced trouble in the matter of hiring help and have consequently quit fishing. But with the aid of the "Seahorse" the stock of the tanks has been repleted to such an extent that the Aquarium has just been enabled to exchange some rare and choice specimens with the Boston, Philadelphia, and Detroit Aquaria, which were badly in need of them.

Among those freaks now present in the Aquarium tanks, thanks to the work of the "Seahorse," may be mentioned the puffer fish, well named because upside down or right side up he can relax to normal or blow himself up to four times his natural size. Then there are the shark suckers, very odd chaps that somewhat resemble a flotilla of submarines in dead storage. They take their imprisonment on indeterminate sentence philosophically.

The prickly ray, a somewhat angular freakish specimen of the deep, must not be overlooked, as he has

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The rate at which moisture advances through the sand in this inclined trough indicates the speed at which capillary action robs the irrigation ditch of its water

What Happens to Ground Water and Why

By S. R. Winters

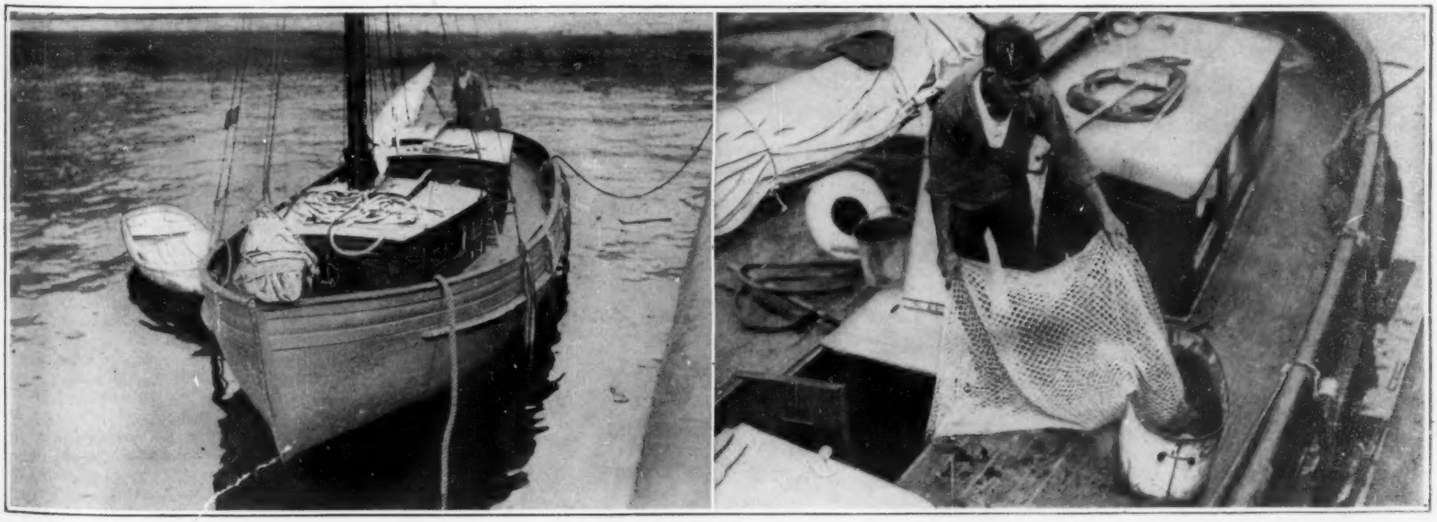
AS a thief in the night, the water supply of irrigation canals is absorbed and robbed by the soil which is necessarily given quarters in the conveying channels and impounding reservoirs of the arid region of the West. Capillary action is the force in operation which is credited with appropriating water not accounted for by direct percolation and evaporation. The irrigation engineer has heretofore found scant information on the subject; hence the value of a series of experiments recently conducted by the Drainage Division, United States Bureau of Public Roads, under the direction of the senior irrigation engineer of its Berkeley, Cal., laboratory.

What is the significance of capillarity as an agency in stealing water from irrigation works, does it play a conspicuous part in distributing, within the soil, moisture applied in irrigation, and whether it conspires with plant growth along the canal bank in consuming water designed for producing crop wealth on arid lands—these and similar questions prompted the scientific study which required special apparatus. Duration and frequency in the distribution of harnessed water constitute an uncertain equation of constant concern to the irrigator. Uniform distribution of water and the maintenance thereof cannot be ignored if dry lands are to be transformed into crop-producing areas. Likewise economy in the application of water is a factor when even the offerings of the clouds are not to be had for the asking. Obviously, the capillary movement of soil moisture is not foreign to the proper construction and operation of conveying channels and impounding reservoirs—avenues for the economical application of water to the fields.

The tests were pronounced in their conclusions that the movement of moisture by capillary action is much slower and not so extensive in the absence of free water as in the presence of the latter. Gravity plays a conspicuous rôle in the capillary movement of moisture when wet and dry soils come into contact. The force of capillary attraction is greater in a horizontal direction than the upward tendency in vertical boxes, but not so great as the downward movement. If the variation in movement of moisture in the several test boxes, as representing the upward, downward and horizontal positions, is primarily attributable to gravity, the conclusion of the government irrigation engineer is that Newton's law is the outstanding influence in the capillary distribution of soil moisture.

The rate of movement of moisture, as sketched on a diagram, shows its progress in the lighter soils is more rapid for the first few hours and then slackens its pace more quickly than with the heavy soils. The heavier soils maintained a more uniform variation than the lighter soils throughout the experiment. The light Idaho land, for example, evidenced a variation of nearly 250 per cent in the total distance moved during

(Continued on page 357)



Left: General view of the vessel, which measures only 35 feet long, over all. *Right:* Removing specimens from the tanks aboard the "Seahorse," to be conveyed to the aquarium

The "Seahorse," craft with which the New York Aquarium conducts its search for fresh material

The Vest-Pocket Automobile

European Super-Flivvers that Are Designed to Get 75 Miles, or More, Out of a Gallon of Gas

THE price of gasoline is one of the questions of the hour to the large and ever-increasing automobiling public. The figure at which the elixir of life for Tin Lizzies and Sumptuous Sixes retails is not fixed; to borrow an expression from the Einstein Editor and his followers, it is "fixed with respect neither to time nor to place." At one time during the past summer two commuters from different parts of New Jersey found on comparing notes that while one of them was paying 37 cents for the indispensable fluid, the other was getting it for 33; while in Newark, half way between their respective home towns, it was to be had for 32, 31, and even for 30 or 29½ cents. Again, the price in one of the communities to which these remarks apply has within the past four months dropped from 35 to 26 cents, where it remains quite firm.

If the automobile owner of some years' standing feels that these prices are inordinately high in comparison with those of the days when he used to get the very finest brand of liquid lightning for 9 cents, and when he cried out to high heaven that he was being robbed if the proprietor of some roadside establishment far from the center of things demanded 11 cents, he doubtless has reason for this feeling. But if he will compare his present situation with that of the British or Continental car owner he will find that he has a good deal to be thankful for, after all.

One of the lightest of the British attempts to compromise between the automobile and the motor bike

For one thing, granted that he has the price, he can get gas wherever he wants it, whenever he wants it, and as much as he wants. Over large regions of the Continent, especially in the territory east of the Rhine and the Alps, there are practically no supplies of gasoline outside the very largest cities, and little enough in them. He who would make a trip of any magnitude must necessarily carry with him all the fuel he will need to get him to his destination, for he will hardly find any on the road at any price at all. And even in the countries like England and France, where "petrol" is theoretically available, the unfortunate motorist who runs out of it may have to pick it up here, there and the other place by the quart or even by the pint. This is to be taken literally, and not at all as a figure of speech. When gasoline is rationed in England, which is pretty much all over the Kingdom and pretty much all the time these days, the quantity which it is allowable to buy in one place at one time is prescribed in pints—and sometimes it doesn't come to enough pints to make a gallon. And as though things had not come to a sufficiently desperate pass when the owner of a huge six-cylinder, seven-passenger bus of ancient vintage that was a gas hog when it was new has to figure his fuel requirements in terms of miles per pint of petrol, he is charged for it—when he can get the stuff at all—a price which at present exchange rates comes to something like 75 cents per gallon.

With this condition more or less prevalent all over Europe, it is not difficult to understand the current trend of automotive design on the other side of the water. Even in the United States engineers and designers are taking cognizance of the fuel situation, both as regards quality and as regards price. Their efforts so far have been confined to new carburetors and new attachments for carburetors and for intake manifolds—attachments that go to make a very lean mixture sufficiently explosive so that the car may run with a carburetor adjustment that would ordinarily mean instantaneous stalling. But while this moderate expedient is adequate, for the present, for whatever of gas problem we have here, it would not do in Europe. The difference between 16 and 32 miles per gallon is considerable but not enough. So throughout Europe we find a concerted effort to put on the market an instrument of travel which shall, in general terms, combine the fuel performance of the motorcycle with the roadability of the automobile.

The most extreme of these baby conveyances that we have seen is the one which we illustrate first. It is of British make, and is hardly an automobile at all, being rather distinctly a motorcycle in all respects save those of wheel arrangement and chassis lines. It is strictly a one-passenger affair, as are a good many of the vehicles of the latest vintage; and it is claimed to be the smallest, lightest and cheapest thing of its sort in the world. The makers, of course, claim that it is the smallest, etc., *automobile* in the world; but we refrain from repeating this claim verbatim through doubt as to where the automobile ends and the cycle-car begins. In any event, it is driven by an engine that is strictly of motorcycle type; and the whole outfit, engine and all, weighs no more than 150 pounds. Its price of 79 guineas compares favorably with the usual cost of small cars of European manufacture, though in this country it could hardly compete with the standard 510-dollar variety. Its fuel consumption is not stated, but undoubtedly it will go 75 miles on a gallon, if not more.

Another British design of much ingenious novelty is the apparatus of our second photograph, with its strong suggestion of the lines of the wheeled invalid's chair. Here the driver and his passenger are accommodated out in the open air, rather than being given a place actually in the machine, which lacks a body altogether. No details of its performance or weight are vouchsafed; but it will be noted that like most of the breed, it goes in for tire economy as well as low fuel consumption. This of course is very fine in buying the machine new; but we can easily imagine circumstances under which it would be utterly impossible to replace a used-up shoe of such bizarre dimensions. Even in this country, users of the less usual small cars taking tires 28 by 3 or other odd sizes are sometimes rather badly up against this proposition. But if the problem were to be solved by the purchase with the car of enough spares to guard against emergency, and by the certainty that the manufacturer of the car was a permanent institution and would not blow up early next week, the main disadvantage of this style of conveyance, as we see it, would be eliminated.

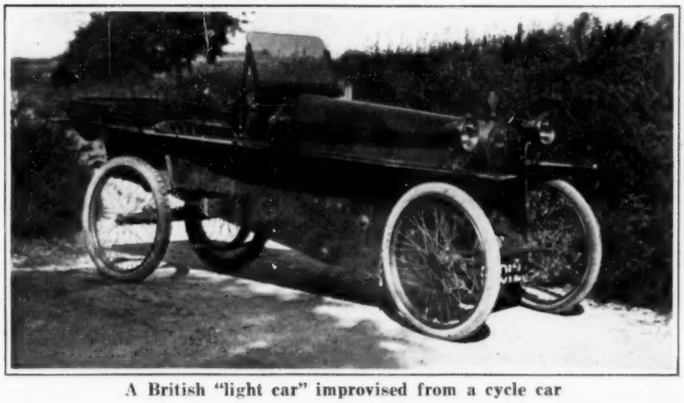
Another English model built along somewhat novel lines

The three-wheel feature is almost universal in these light cars that look toward a greatly increased gasoline mileage, and for the most obvious of reasons. Even when the vehicle attains a quite ambitious size, it continues to go on three supports, though opinion seems about equally divided whether the single wheel should be in front or at the rear. A German model in which the former alternative is selected enjoys the rare merit, according to the gentlemen interested in its sale, of taking the street corners at full speed without danger. It is not specified whether it rolls about them on two wheels like a bicycle, or whether its lightness enables it to fly around them or to jump over them; so there seems to be a certain degree of *non sequitur* about this claim, which however we repeat for whatever merit it may have. Perhaps the most noticeable feature in the photograph is the obvious fact that if anything goes wrong with the controls, the driver will not have to lift the hood to find out where the trouble lies. We opine that if this machine were to become general, the degree to which the machinery-struck small boy could stand on the curb and watch the internal workings function on the passing cars would soon lead to a generation of natural-born garage mechanics. Seriously, however, we want to suggest that some of our American manufacturers, without at all copying the eccentric lines of this goose-neck affair, might well emulate it with regard to accessibility of some of the major parts that require frequent adjustment, like—well, to be disagreeably specific, like the timer. We are quite certain that the driver of our picture will not have to tear down any radiator to find whether the failure of his machine to develop a spark is due to commutator trouble.

A German three-wheeled car of rather ambitious proportions

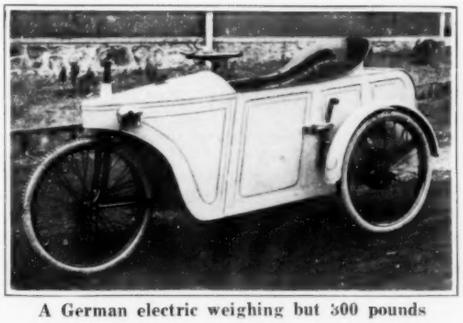
Doubtless the most auto-like of all the machines which we show is that at the

top of our second page, which is a car reconstructed by Mr. Angus Love, of London, from an ordinary cycle car. Mr. Love assumes that under the disguise of roller blind and other home-made "improvements" (the quotes are his) we will recognize this; but we are not at all sure that we should. At the time of sending us the photograph, in December, Mr. Love had operated the machine for nine or ten months, covering several thousand miles with two up plus luggage—which for the provincial American may be translated as baggage. He tells us that the car as illustrated, with fuel and oil and electric light, weighs 500 pounds. We think for the extra 350 pounds it makes a very respectable showing beside the first of our pictured types. It is driven by an 8-horsepower twin-cylinder air-cooled engine—the features of two cylinders and air cooling being quite general among the machines which we are describing. The transmission is by chain to a three-speed gear-box and thence by a one-inch rubber belt to the solid rear axle. It will speed up to 45 or 50 miles per hour on the level, and it will of course hold its own with anything on the hills. The fuel consumption is about 68 to 72 miles per gallon with gasoline or 75 to 80 with benzol. The car is rather superior, apparently, to most of its fellows in the excellence of the springing and in the general comfort which it affords. Mr. Love states that he did a run of 235 miles from London to North Devon in one day, using up 13 hours of time including stops for meals, and 3¼ gallons of fuel. He considers that this ought to "give the designer of the conventional automobile furiously to think," and with fuel at 75 cents a gallon we should suppose it might. The car, in its present state as we understand it, cost him 165 pounds. Incidentally, if everybody who takes occasion to show us one of these things would tell us about it as fully as Mr. Love has done, we should consider that the world was getting better.



A British "light car" improvised from a cycle car

Strongly along bath tub lines is the German electric which we illustrate next. A curious feature of this machine is that the steering column is adjustable, so that it describes a graceful circle about the person who is getting aboard, instead of forcing him to climb over, around and under it. We have ridden in regular automobiles where something of the sort would be an improvement. This machine weighs 300 pounds and takes a load of 200 pounds additional without protest. It travels at a speed of from 2 to 25 miles per hour, indicating that it could not be driven on American roads without the certainty of getting run over. It goes 50 kilometers (30 miles) on one charging of the battery—we should suppose that with slight additional permanent weight this showing might be materially improved. It develops one-half horsepower at 8 volts and 200 amperes. It seems to be rather similar to the "Electrisches Kleinautomobil" recently illustrated in these columns.

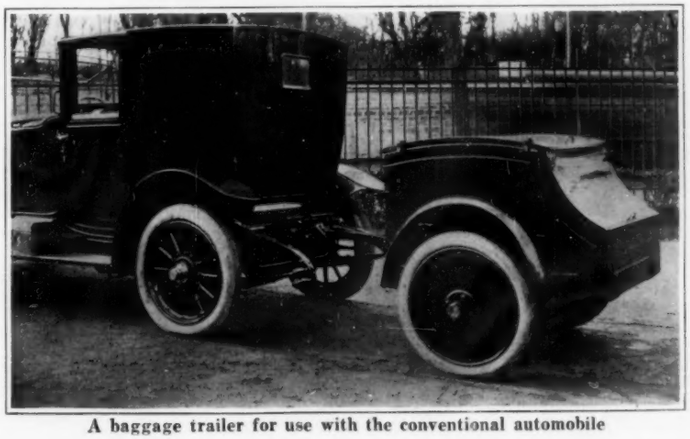


A German electric weighing but 300 pounds

A Swiss motorized tricycle which it is difficult to accept as more than a toy is the next item on the list of near-automobiles. The most surprising feature of this one is its low weight of 32 pounds. It is suggested that it will develop a brand new economy of its own, in that after using it, the owner can tuck it under his arm and take it upstairs to his apartment, about as we used to do with our racing bicycle in the days when we lived three flights up. Whether he is to park it under the kitchen sink or behind the bed or hang it on the hatrack is not specified, the point of the argument being that the expense of garage hire is nothing in the life of the proud proprietor of this pushmobile. The cost is moderate enough, being only 650 francs (of the Swiss variety that are still worth 17 cents). Gasoline mileage is not specified, but if it is inversely proportional to the weight it must be sufficiently enormous.

A Swiss "machine" that weighs but ten pounds more than the ordinary bicycle

Our last picture has to do with an attachment for the regular automobile. It is always a problem, especially in the case of a closed car, to know just how to deal with a trunk. We should doubtless be startled to encounter this trailer on the road, but if driven into a corner and pressed to state exactly what is the matter with it we should be at a loss to particularize. Architecturally it certainly is a part of the car that hauls it, and if this were of different style from that shown in the picture it could be made a part of it. And with the great vogue of auto-camping the spectacle of a passenger car towing a freight trailer is not so entirely unique as it was at one time. Indeed, we met a dilapidated vehicle of indeterminate age and make the other day on the Lincoln Highway a few miles out of New Brunswick, which surprised us a good deal more with the tremendous variety of things that it had tied and strapped to it than it could possibly have shocked us if these appurtenances to life on the road had been decently stowed away in a trailer of some sort.



A baggage trailer for use with the conventional automobile

Long Hollow Steel Bars

AN order of a unique character has just been placed in Sheffield for 160 hollow steel bars, each measuring 62 feet long by 2 inches in diameter, to be used as rock-boring drills. They are by far the largest drills ever made for such a purpose, as the length of the hollow bars hitherto rolled has averaged from 10 feet to 12 feet, and even then the difficulties of production have been considerable. It would not be possible to do the work contemplated but for the existence at the local armament works of mills of exceptional power and size. The bars are to be rolled from 8-inch square blooms weighing nearly half a ton each. A hole is first drilled through the length of the bloom and plugged, and the stopping is removed on the completion of the rolling process. The purpose of the hole in the bars is to provide a passage for water or lubricant. The transport of the material through the streets will have to be done during the night-time, and a dray is being constructed especially for the purpose. The placing of this order in Sheffield by an American firm is a tribute to the efficiency of Sheffield plant and workmen.

Belgian Experiments on Palm Oil as Motor Fuel

A SERIES of experiments begun in 1914, but interrupted by the war, has recently been resumed in Brussels on the use of palm oil in internal-combustion motors. The question of motor fuel in the Belgian Congo is a serious one, since a ton of crude oil delivered at Kinshasa in metal casks has an estimated price of 2,000 francs, as against 1,050 francs in Brussels. Palm oil, on the other hand, costs on the native market an average of 25 centimes per kilo, but varies in price between 8 and 40 centimes. The calorific power of palm oil is from 20 to 25 per cent less than that of crude oil, so that a relatively larger consumption of palm oil must be reckoned with, while the comparatively high temperature at which palm oil fuses (37° C.) indicates the possibility of rapidly clogging the motor.

According to engineers closely connected with the experiments, without constructing a special palm-oil motor, it was necessary to find a machine in which complete combustion is assured by a complete vaporization of the fuel, which should be introduced in a quantity strictly proportionate to the load. It was further essential that the gaseous mixture should be constant and capable of regulation by a supply of water, varying according to the load and the amount of oil being fed in. Thorough clearing of the exhaust gases was also a requisite.

The Belgian colonial company for the Congo has been successful in finding a two-cycle semi-Diesel motor of Swedish manufacture developing 10 horsepower at 500 revolutions per minute which satisfies these conditions, and motors of larger and smaller sizes of the same character have been run on palm oil with good results without special changes for the use of the new fuel. The palm oil, which at normal winter temperatures in Belgium has about the consistency of soft butter or lard, is placed in a tank divided into three compartments by wire screening. As this tank is heated either through the circulation of hot water from the cooling system or other mechanical means, the palm oil liquefies and passes through the screening to the feed pipe leading to the injection pump. For experimental purposes this motor is started on crude oil. Once it has warmed up, and as soon as the palm oil begins to liquefy, the crude oil is turned off, so that the engine then runs on palm oil exclusively with no slackening of the number of revolutions or of the power produced. At the temperatures prevailing in the Congo, engineers claim that this motor could be immediately started on palm oil, and it is proposed to install motors of this type on launches and other small river craft, as well as to conduct further experiments for their use in industry and traction. Analysis shows that there are no incombustible components in palm oil, and, contrary to general expectation, the oil neither clogs the motor nor leaves any perceptible solid residue behind it.

"Banking" Electricity for Universal Use

Making Use of Water Storage and Transmission Lines for Providing Power at Low Costs

By Professor Reginald A. Fessenden

ELECTRIFICATION can be applied universally by means of a simple and extremely practical system of "National Power Banks" from which electric power can be withdrawn and in which it can be redeposited by consumers at any desired time.

These "National Power Banks" can be spread throughout the country, being established in or near large cities or wherever most convenient. They can be used both for main and subdistribution of electric current. Their establishment will enable power generated at gigantic stations located in the coal regions of Pennsylvania or elsewhere to be delivered and stored at Boston, New York, Philadelphia, Washington, etc., *i.e.*, all over the United States. The cost of the power, delivered at Boston or New York, should not exceed one-fourth of a cent per kilowatt hour.

Establishment of these banks would not mean that the present power stations in New York and Boston, etc., should be abandoned, for they generate power themselves at a rate of less than a cent per kilowatt hour, and by connecting on to the storage network, and so being able to run at unity power factor, can reduce production cost down to nearly one-quarter cent per kilowatt hour. They will make their great saving, however, in the secondary distribution, which at present is the most expensive and wasteful part of the system, by using storage at points in the secondary distribution, and pumping their access power at night time back into the power bank.

These banks would not be rich men's banks. All over the country districts any farmer with a windmill can hitch on an asynchronous generator to his windmill, with a sealed reversible meter, and, leaving his windmill run all night, get credit for the power pumped by him back into the storage network, and be debited with what he takes out. Such an arrangement is shown in our drawing on page 341. During the long winter months he should have a substantial balance, unless he uses it for heating, which becomes quite practicable with the low cost of generation and delivery rendered possible by the power banks.

One obvious effect of the existence of such a storage network is that local dislocation of business due to coal shortage, etc., will be eliminated. Numerous other obvious good effects of such a system could be cited.

The conditions necessary for universal electrification under my power bank plan, or any plan, are: Low cost of generation, low cost of transmission and low cost of distribution.

Low cost of generation depends very largely on power factor—the percentage of power being utilized of the total generated—and we will assume first a 33 per cent factor. Administrative geniuses like Insull in Chicago have done much better, but 33 per cent is more nearly representative of ordinary conditions.

(*a*) Generation from coal. This is at present the cheapest method for large quantities. Using extra large Detroit type boilers and 50,000 kilowatt turbo-generators located at the mine mouth, the cost will be in the neighborhood of one-quarter cent per kilowatt hour.

(*b*) *Generation by water power.* This is the next cheapest, and will average about one-half cent per kilowatt hour.

(*c*) *Generation by tides.* In 1909 I made a very complete investigation for some Montreal capitalists of the possibilities of the Bay of Fundy. Several quite practical alternative schemes were laid out, and it was found that the cost would be slightly less than one cent per kilowatt hour. The engineering problem was a quite simple one. A fundamental difficulty existed, however; *i.e.*, that after the power was generated there was no body of users near enough to utilize it. So the project was dropped.

(*d*) *Generation from solar heat.* The latest value of the Langley radiation constant is about 2 calories per minute per centimeter square. This means approximately the energy of one Niagara Falls for each square mile. The constant is as a rule larger in winter than in summer on account of the greater transparency of the atmosphere, the largest values having been found in winter in Siberia. As I have pointed out elsewhere, this method is not limited to daytime, as negative radiation may be used at night time, cooling the vapor from sea water after passing it through a low-pressure steam turbine. Some calculations I made show that a negative radiation plant operating in Alaska in winter would have about the same power output per dollar of plant as a positive radiation plant operating in summer in the tropics.

The method used would, of course, be low-pressure steam turbines of large capacity and the water flowing in this stream over the surface of large shallow tanks, covers of suitable absorption band glass, good condensing facilities, etc. In a paper read before the British Association in 1910 and printed in full in the London *Times*, I have given tables of the average calories received during the entire year per square centimeter of ground surface. The cost per kilowatt hour of power produced by this means is at present about two cents per kilowatt hour. It will undoubtedly be reduced in the future, and it is evident that such places as the Desert of Sahara will before long be as valuable as coal country. Underground waters exist over a great part of the Arabian and some other deserts.

PROF. REGINALD A. FESSENDEN, originator of the "National Power Banks" plan of storing electricity for universal use, is a well-known figure in the electrical world, both in the United States and European countries. His system, explained in the accompanying article, was under consideration for installation, in part at least, by the Danish government when the Great War broke out, and the matter was dropped for the time being. In conjunction with wind power, the system is being considered for New England and the Eastern States. Inventor of the wireless telephone and the electrically driven battleship, Professor Fessenden was, in 1909, the first person ever to telephone across the Atlantic. Among his other inventions are an iceberg detector, a smoke-cloud protection for British tanks, used extensively at the Battle of Cambrai, and a method of locating enemy guns by sound. The last invention was perfected by Professor Fessenden while he was acting as a technical expert for the Canadian government during the Great War.

Professor Fessenden was one of the engineering commissioners of the Ontario Power Commission which, in 1906, planned and recommended the distribution of power from Niagara Falls over substantially all of Western Canada. The difficulties met with by the pioneers in this work were overcome by Professor Fessenden's invention of the series of small electrostatic capacity insulator, capable of carrying potentials up to 1,000,000 volts. With all this behind him, Professor Fessenden may put forward a scheme like the one here described with no danger of being branded as an impractical visionary.—THE EDITOR.

(*e*) *Generation by wind power.* A 500-foot windmill may be relied upon to produce an average of 1,000 kilowatts at a cost of about 8 cents per kilowatt hour. A windmill is, however, an extremely wasteful means per dollar of cost of construction for taking power from the wind, and with more scientific construction the cost can be brought down. The problem of placing windmills behind each other (or other energy absorbing structures) is a quite amusing one. At first sight it would seem as if the shielding effect would be enormous because the problem has the appearance of being related to the diffusion of heat through a gas. But in reality the problem is one of large scale convection, and calculations and experiments show that the shielding is relatively small and that wind energy convects downward at a very rapid rate behind each energy absorber.

(*f*) *Generation from Internal Heat of Earth.* This has been discussed so thoroughly by Sir Charles Parsons that it is sufficient to say that it appears thoroughly practical, and at a reasonable cost. It is simply a question of the value of the ratio of rate of heat diffusion through rock to cost of excavation, which does not vary with the size of the plant (above a certain size).

With all the above sources, the price at which the power can be sold at the gigantic generating stations will vary inversely as the power factor, because in each case if the plant is sufficiently large and properly designed and located, the fixed charges will be by far the main item. Therefore, if the power can be stored at negligible cost, so that the generating stations can deliver their full capacity at all hours of the day and night, *i.e.*, if they have 100 per cent power factor, the cost of production per kilowatt hour will be as follows:

(1) Coal—one-tenth cent per kilowatt hour.
(2) Waterfalls—one-fifth cent per kilowatt hour.
(3) Tides—one-half cent per kilowatt hour.
(4) Solar heat—one-half cent per kilowatt hour.
(5) Wind—one-half cent per kilowatt hour.
(6) Internal heat—not unreasonable.

Low cost of transmission depends on the resistance and corona losses and power factor and transforming apparatus cost.

As regards resistance, when I was designing my transatlantic wireless stations at Brant Rock, Massachusetts and Machrihanish, Scotland, in 1905, I was faced with the problem of providing strain insulators to operate under a stress of 100 tons, and a voltage of 1,000,000, at a frequency of 250,000 and with 100 kw. of energy behind the voltage. No such insulators were known, but I found that by putting a number of insulators in series in such a way as to keep their mutual capacity small and placing shields so as still further to equalize the electrostatic stress curve, the thing could be done; and though the towers frequently were operated at the full million volts for hours at a time, and though a tower was sometimes struck two or three times by lightning in a single night, there was only one instance in five years of insulator loss. It may be said, therefore, that it is quite possible to insulate transmission lines up to at least 500,000 volts.

Another difficulty is the corona loss. This also was overcome so that there was no measurable or visible corona loss up to 1,000,000 volts with wires only one-tenth inch in diameter. The method was very simple, but would take too long and is too mathematical for insertion here; but it means that if there is sufficient power transmitted to make it worth while, corona loss can be eliminated at negligible cost.

Power factor is always bound to make trouble unless storage is used. If the power is stored, the power factor can be kept at unity and a lot of trouble from surging, etc., eliminated.

Without storage, transforming apparatus must always be used, and must always be quite expensive. If the power is stored, transforming apparatus, *i.e.*, primary transforming apparatus, can be eliminated.

In cost of conductors, especially with high power lines, the cost of the whole transmission line depends not only on the voltage but also on the power factor. If, for example, the power factor is 33 per cent and the peak is 300,000 kw., obviously, if storage is used so that the power factor is unity, the line need only be of sufficient size to carry 100,000 kw., and since the maximum loss in the line is I^2R, the conductor can have one-tenth the cross section; or, if the same size conductor is used, may be ten times as long, *i.e.*, power may be transmitted from the big generating stations over an area 100 times as great as before. [I represents current; R the resistance.]

This is not really a fair comparison, but this whole subject of economical line design is extremely complicated, and what I have said is very nearly correct, though other mutually canceling considerations come in. To take a specific case, power is at present being delivered at Copenhagen, in Denmark, from Sweden, through a submarine cable. Assume Copenhagen's power factor to be 33 per cent. Then, obviously, if storage were used, three times the power could be transmitted through that cable for the same transmission cost. And even more, for direct current high voltage current could be used, with still further reduction in cost; and, for the same insulation strain on the cable, six times the power could be transmitted, thus reduc-

(*Continued on page 357*)

Correspondence

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.

The Einstein Contest and the Readers

To the Editor of the SCIENTIFIC AMERICAN:

I have read Mr. Bolton's article with a great deal of interest. It is capital, concise, and excellent in every way. I have enjoyed it thoroughly, and I only hope that the average reader of the SCIENTIFIC AMERICAN will enjoy it as much.

I now have a suggestion to offer, of which the practicability depends in part on how much you propose to publish of the other articles. You have now found the paper which experts believe will give the most instruction to the readers of the SCIENTIFIC AMERICAN. Why not find out now which article the readers themselves think is best adapted to their wants? Why not publish a few of those papers that you personally consider the best, and let your readers vote on them? It seems to me that if the papers are carefully selected, such a vote would furnish a very unusual opportunity to secure valuable information, not only to the editor, but also to others, as to the mentality of the average intelligent public. W. H. PICKERING.

Harvard College Observatory,
Mandeville, Jamaica.

To the Editor of the SCIENTIFIC AMERICAN:

Bolton's essay on Relativity is a master composition in the English language let alone being of supreme interest as a popular exposition of Einstein. I must have a copy for my library as one of the treasures of literature. LEE H. MCCOY, Pueblo, Col.

To the Editor of the SCIENTIFIC AMERICAN:

In your issue of February 5th you published an essay on Relativity, followed by a second essay on the same subject in your issue of February 19th. I venture to think the second essay is the better of the two.

This opinion is not of any value but the process by which it is arrived at may interest you.

The first writer is a scientist who speaks and thinks fluently in scientific language just as a Frenchman does in French; there is no trick about it; it is the easiest way. Thus this writer deals freely in abstractions and as little as need be in concrete things. The second writer deals as largely as possible in the concrete and projects his own abstractions as he needs them: taken by the arm, the reader, before he is aware of it, has achieved an altered attitude of mind, for example:

Both writers deal with four dimensional space from the same point of view, and in the same way, but the second writer has a nimbleness all his own: When his reader has gone over the matter a second time he has already convinced himself that four dimensional space is according to regulations: that he had always thought so: that three dimensional space is only an abstraction: that he had never quite understood why people took it seriously, "don't you know." The first writer has another sort of nimbleness; he entangles his readers in his graceful involutions of expression; it is obviously the reader's business to disentangle himself as best he can. It implies that the reader has intelligence to share, and he lets it go at that.

You may claim, I think, that the first writer prepares the reader's mind for the second. The second writer does not seem to need a John the Baptist to prepare the way before him. The first is Brutus; the second is Mark Antony. Doubtless the judges are able, scientific people; perhaps it was a layman's job; or, rather perhaps, this is an example of relativity. It is admitted that your choice is valid from the scientific system; may not my choice be valid from the reader's system? CHAS. STRANGMAN.

Victoria, B. C.

To the Editor of the SCIENTIFIC AMERICAN:

To say the least, a statement where the Einstein judges went wrong looks cheeky, particularly coming from one who has no pretensions toward scientific attainments. But be it remembered that we are of that great body of plebeians for whose especial information the Prize Essay, under the terms of the contest, was written. And none but those of the uninstructed multitude can properly say whether this essay has failed of its mark or not. The scientists, as judges, may conclude that the claimant for the prize has satisfied his case, but it remains for the common jury to record the verdict. The writer therefore considers that he is privileged to pass humble criticism upon this matter *from the viewpoint of the layman.* "Laymen can always benefit experts by suggestions, if in no other way," says Mr. F. J. Clarke in "Self-culture," and it is believed that not only laymen but the expert also will concede the truth of what is set out below.

This apparently cheeky letter is in one way a compliment to the Einstein judges, for the submission is that they know too much. So well versed apparently are they in the ideas connoted by scientific terms that they have failed to realize there could be any so hopelessly uninformed as unable to appreciate, in all particulars, what the prize essayist was talking about. When this essay appeared, the writer commenced to read it with avidity, for he was anxious to know what the Einstein theory means; and here, thought he, will be found, couched in plain English and surrounded by no ambiguous terms or reasoning, what he is after. Alas for our ignorance and, perhaps, our stupidity! Avidity quickly gave place to diffidence, and diffidence to dismay, as the writer realized that, for him, the essay was a sealed book.

I entirely agree with the Messrs. Parkhurst when, in their letter to the editor of this Review of 5th March last, they say the essay "was a gross miscarriage of common sense under the terms and articles of the contest." Mr. Bolton's article meant nothing to me for the simple reason that it contained, at the precise point where clearness of diction and of ideas was essential, terms with which I am entirely unfamiliar and an expression of ideas the impenetrability of which could not and would not yield to all the reasoning my dull and uninformed intellect was able to bring to bear upon the subject. These facts should not be lost sight of. The paper was absolutely beyond my comprehension, and the whole article was, for me, an egregious failure. Fortunately, it is not so now. I have read the other essays since reprinted in these columns, and particularly No. III. by Frank E. Law and others, and, in the light of what is therein contained, I am enabled to peruse the Prize Essay with some degree of assurance. Let me, however, make this much clear: The comments which *directly* forced perspicacity upon me were not contained in any of the contesting essays, but were those most clear, most useful, and most significant short statements which the Einstein Editor himself interpolated in article No. III. His dicta appeared neither too soon nor too late, but precisely at the exact point where something was required, and urgently required, for conveying adequate comprehension.

Wherefore, the writer is of opinion that the Prize Essay, in so far as it obviously did not comply with the main term of the contest, namely, that it should be clear and appreciable to the uninitiated, is a failure, and a marked failure at that. As an accurate exposition of the Einstein theory, I, of course, attempt no criticism, and have no reason to doubt that the judges selected the essay which most *correctly* interpreted the matter; but they apparently lost sight of the layman, and inasmuch as the essay failed of its primary purpose, so did the judges fail in not recognizing the defect. Their error was one of procedure, not one of substance. But procedure, in this instance, was of the essence of the contract.

And now, Mr. Editor, if there be any who think I may be wrong in my conclusion, and that I am likely enough so far beyond the pale of intellectual capacity as to be unable to appreciate the Einstein theory in the light of any possible interpretation, let me produce the pages of the SCIENTIFITC AMERICAN in proof of my statement. Why was it thought *necessary* or *useful* to further elaborate the theory, as was done in Article No. III. above referred to? And why was it still necessary to go outside even the essays submitted in such further elaboration? There can surely be but one answer—for the purpose of elucidating for us unsophisticated mortals some important points which apparently the Prize Essay failed to make clear. And that, it seems to me, sufficiently bears out my contention.

In conclusion, may we ask to see the Messrs. Parkhurst's essay? We realize it is impossible for all or nearly all the essays to be reprinted in these columns, but, judging from those gentlemen's criticism of the Prize Essay, we are led to believe that a popular and comprehensible exposition of the subject will be found in their article. May we have it?

Duncan, B. C. C. F. DAVIE.

To the Editor of the SCIENTIFIC AMERICAN:

Your author in the present case was not one of the three hundred who made the bold charge into the Einstein Essay Contest; neither is be one of the twelve who knoweth all things. We did go so far however as to have paper on the typewriter and were wading boldly in when someone passed, looked over our shoulder, and said, "Fools rush in where angels fear to tread."

The advertisement announcing the contest said: "Five thousand dollars for the best essay on the Einstein Theory so written that it can be read with profit *by an ordinary intelligent person with no special mathematical training.*" Mr. Bolton did not fill the contract. Mr. Francis disobeyed Rule II of the contest, his essay being full of technicalities. Mr. Law's essay was the best of the three. In it we begin to see daylight. If you should print another it may bring us into the full sunshine. The first two men evidently forgot they were to write so that the layman could understand. Their essays were good from the view of a higher college man. Your readers looked for something the "ordinary person could understand." It has not been produced.

Would it not have been well, perhaps, to have selected one of the judges from the ordinary ranks? Men skilled in the higher mathematics are prone to think in the higher mathematics. As it is true that "we are so earth-bound that it is hard for us to get away from earth-bound habits of thought," so it is true that we find it hard to reverse the process, so that we can make universal things understood by the ordinary man.

Pittsburgh, Pa. THOS. J. ARMOUR.

To the Editor of the SCIENTIFIC AMERICAN:

Whether or not I comprehend the Einstein Theory of Relativity, the reading of the article by Montgomery Francis in the issue of February 19 has settled for me one burning question; the one so often propounded: "How old is Ann?"

The answer is fully comprehended by the quantity $\sqrt{(X-x)^2+(Y-y)^2+(Z-z)^2-(CT-et)^2}$ which is the value, measured along a geodesic, of the space-time sequence or interval between the nativity of Ann and her present location in the same. The values of x, y, z, and especially t, being resolvable into entirely different quantities according to the observer's frame (of mind) and dependent on the observer's speed (of living) as compared with Ann's speed.

This squares absolutely with all general experience and observation, which, although far from being proof (see SCIENTIFIC AMERICAN, February 19, 1921, page 146, line 40 to 46), nevertheless makes it easier to believe.

Seriously, there is more meat for me in Mr. Francis's article than in the winning essay, for, though the latter seems to be a very able laying down of rules and is undoubtedly perfectly plain to one who understands the subject (it must have been to pull down 5,000 good hard "iron men") to me it is an explanation that does not explain.

Barring a missing M or two in the illustration and a quantity C unexplained, I got along very nicely with Mr. Francis's article.

If you will continue to publish more of the losing essays I hope in time to find out what Mr. Bolton was talking about. J. M. DOCKSTADER.

Woodbridge, N. J.

To the Editor of the SCIENTIFIC AMERICAN:

While I must confess that Mr. Bolton's essay on the Einstein theories was not "written down" to my intellectual plane, I wish to compliment the Einstein Editor on his numerous invaluable contributions on this general subject. M. JENNINGS.

New York, N. Y.

WE had intended long before this to give a place on this page to some of the numerous letters we have received in comment on the Einstein Contest. But the Einstein Editor's time has been so fully occupied with the effort to get the book "Relativity and Gravitation" out at the earliest moment that he has not been able to give these letters the careful reading necessary for selection. The book is now out of his hands, though publication may be a little delayed by a strike of the bookbinders; and this page is the result. We have enough of these letters to fill several more pages, and hope to present some more of them at an early date.—THE EDITOR.

A City Without Water

How Winnipeg Brought the Essential Fluid 100 Miles Across a Barren Plain

By J. F. Springer

THE present city of Winnipeg has a population of perhaps 250,000. This is quite a contrast with 1874, when the figure for population was 5 less than that for the year. In the old days not so long ago, the population was dependent upon local wells for water and upon tanks and barrels carried on carts for the means of distributing what the wells supplied. There was probably never a day in Winnipeg's history until March 26, 1919, that witnessed a satisfactory condition of the water supply. Nevertheless, the city has grown at a fine rate. Even the water obtainable was so hard that it was undesirable for many purposes and practically impossible for others. In short, the city was doomed to severe retardation of its proper industrial development unless a suitable solution of the water problem could be had. However, Dr. Agnew nearly forty years ago pointed out an available source of water in the Lake of the Woods. This is a great sheet of water to the east and southeast with an exceedingly complicated shore line. In fact, this body of water is rather an aggregation of lakes and lakelets connected with one another. It is located mainly in the Province of Ontario and the State of Minnesota, and only to a slight extent in the Province of Manitoba in which the city is situated. Dr. Agnew's judgment has been abundantly confirmed by careful investigation. The great aqueduct which now connects with Winnipeg takes its supply from Indian Bay, which is an arm of an arm of the Lake of the Woods.

There is a notable phenomenon connected with Indian Bay. Twice each year the waters are overturned. That is, water from below will rise in currents every half year. This is due largely to a scientific fact of much interest. In general, liquids become denser and denser as their temperature falls. Water conforms to this rule except in the interval 32°-39° F. (0°-4° C.). The point of greatest density is 39° F. Whether the water increases in temperature or decreases from this point, it becomes lighter. The effect of the winter on Indian Bay is to cover it with ice, whose thickness may reach 4 feet, and hold the water beneath at a temperature level something above the freezing point. The summer's sun melts the ice and warms up the water at the surface. This water being at a temperature less than 39° will become denser and sink. The water of lower density will rise in consequence. Similarly, upon the approach of quite severe weather, the surface water, being above 39°, will upon cooling become denser and sink. The upward currents are accordingly repeated. This fluctuation above and below the critical temperature of 39° results in solid material such as grass and leaves being brought up. So much of such material was brought up upon an overturn in the first year of service that the screen at the intake of the aqueduct was overloaded and damaged. Through the breaks, dirty water and fish found their way into the aqueduct itself. And all this is traceable to the peculiar behavior of water below the critical point.

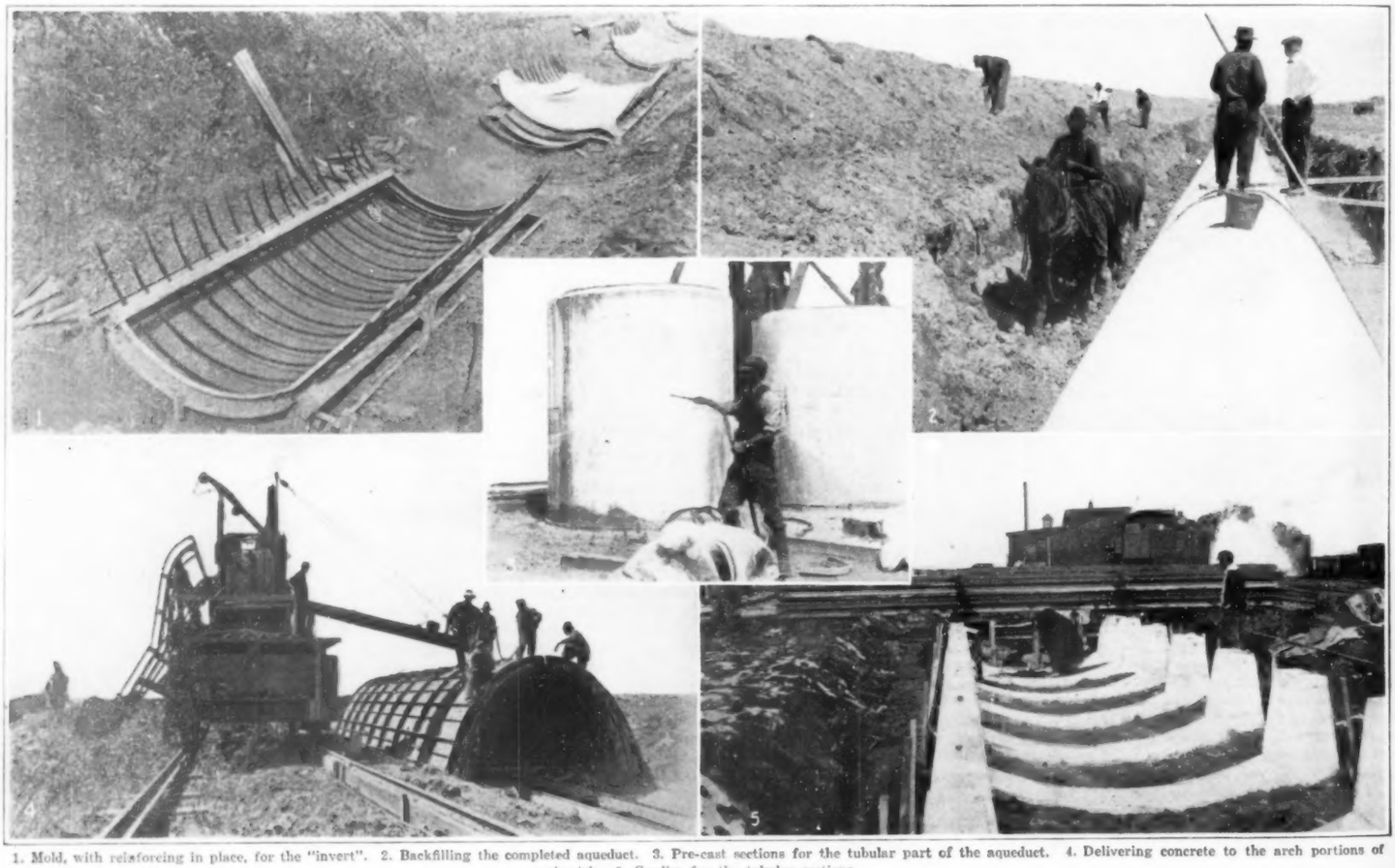
Another interesting matter connected with the source of supply concerns the measures taken to avoid discolored water. In general, the bays which fringe the Lake of the Woods and contribute to it are highly discolored. The reason is that they receive water entering by small streams which flow through swamps and muskegs and bring along all kinds of material. Indian Bay was no exception, its waters having been everywhere burdened with the coloring matter. But Shoal Lake into which Indian Bay empties is comparatively free from discoloration. This is attributed to the effects of time and sunlight. As the dirty water of Falcon River and Snake Lake was mainly responsible for the discolored condition of Indian Bay, the water of the latter could be made suitable if the incoming dirty water mentioned could be diverted into Snowshoe Bay, a nearby arm of Shoal Lake. There was another alternative which would accomplish the purpose by taking the water from Shoal Lake itself. But the former was carried out by constructing a dyke at the west end of Indian Bay and a canal to connect with Snowshoe Bay at a cost of about $147,000. The alternative would have required a 5-mile extension of the aqueduct and a cost of about $1,000,000. The effect of the method actually adopted is indicated by great differences in color of water samples taken on the same day from the two sides of the dyke.

The temperature of the water at the two ends of the aqueduct is just about the same. This statement holds good throughout the year. This is remarkable. The winters are severe in Manitoba, freezing temperature penetrating the ground to a known maximum of 9 feet. "In fact, in Winnipeg, small service mains freeze sometimes in June and July, at that depth." Nevertheless, the cold from the air, penetrating down through the four feet of cover and through the arch of the aqueduct, is unable quite to balance the upcoming heat from the bosom of the earth. The water remains, consequently, at just about the same temperature.

The aqueduct is around 100 miles long, being of about the same length as the Catskill Aqueduct. It traverses a district that is monotonously flat and only infrequently interrupted by water courses. There is a great contrast between the two structures.

For the first nine miles out from Indian Bay, the aqueduct is laid in a cut having two slopes, both very gentle. The gentler of the two is next the bay. Naturally, a larger section of the aqueduct bore would be used here in order to pass the full 102,000,000 gallons per

(*Continued on page 358*)



1. Mold, with reinforcing in place, for the "invert". 2. Backfilling the completed aqueduct. 3. Pre-cast sections for the tubular part of the aqueduct. 4. Delivering concrete to the arch portions of the job. 5. Cradles for the tubular sections

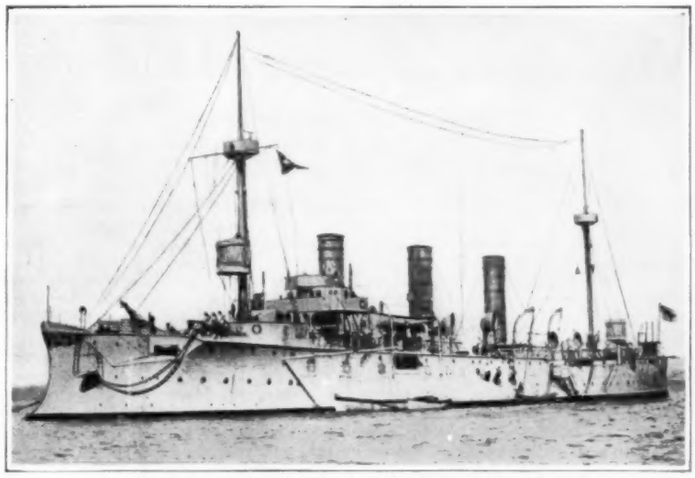
The aqueduct that brings water from Lake of the Woods to Winnipeg over a hundred-mile route

From Cruiser to Tramp

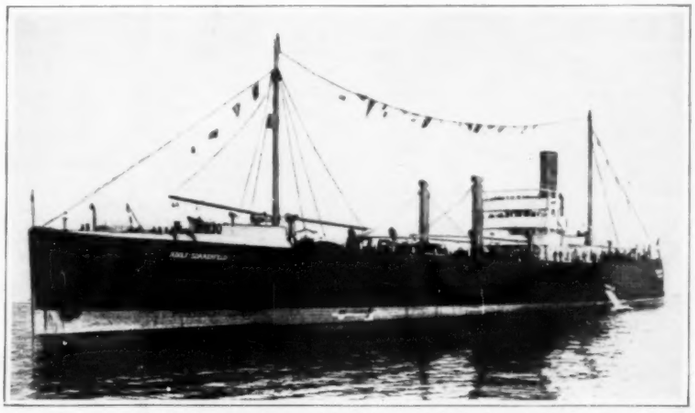
IN the effort to add to the world's depleted fleets of commercial vessels, several nations have taken old warships in hand and have transformed them into merchant ships. In this country the cruiser "Boston," of the famous "White Squadron" was thus changed; the French have done the same thing with the "Dupuy de Lome"; the British transformed a veritable fleet of their smaller extemporized warcraft into merchant ships; and now the Germans have tried to make a serviceable merchant vessel out of the old protected cruiser "Gefion." The ship, before and after, is shown here in two photographs.

The "Gefion," built in 1893, was a small protected cruiser of 3,750 tons' displacement. She was 325 feet in length on the waterline, with a beam of 42½ feet and a maximum draft of 21½ feet. She had a protective deck at the waterline, covering the vital parts of the ship, and her armament consisted of ten 4-inch guns, six 4-pounders, several machine guns and two above-water torpedo tubes. Her machinery included two sets of triple-expansion engines, driving two propellers, and steam was furnished by six double-ended cylindrical boilers. With 9,000 horsepower she made about 20 knots speed. The two photographs show how greatly changed is the profile of the ship. The curved ram has disappeared; a straight stem takes its place, and the deck and hull structure have been faired out to meet it, thus giving the ship the bow of a typical commercial vessel. The topmasts have been removed; but the steel lower masts stand as they were. To secure sufficient deck room and hold space, the three smokestacks and the bridge, together with the guns, ventilators, et cetera, have been removed and a new bridge has been built well astern, with a single smokestack abaft of it. The ten 4-inch guns with their gun mounts are gone, and as the boat now rides the water it would take an expert eye to detect that she had once been a warship. The position of the present smokestack would suggest that the whole of the original boiler and engine room plant has been removed and new motive power installed in its place.

As a rule it is not found to be a paying proposition to attempt to turn warships into merchant vessels, the amount of cargo space in the reconstructed ship being too limited to render such vessels successful freight carriers.



The German cruiser "Gefion" as she looked when devoted to warlike uses



Made over into the freighter "Adolf Somerfeld," she would hardly be recognized as the same ship

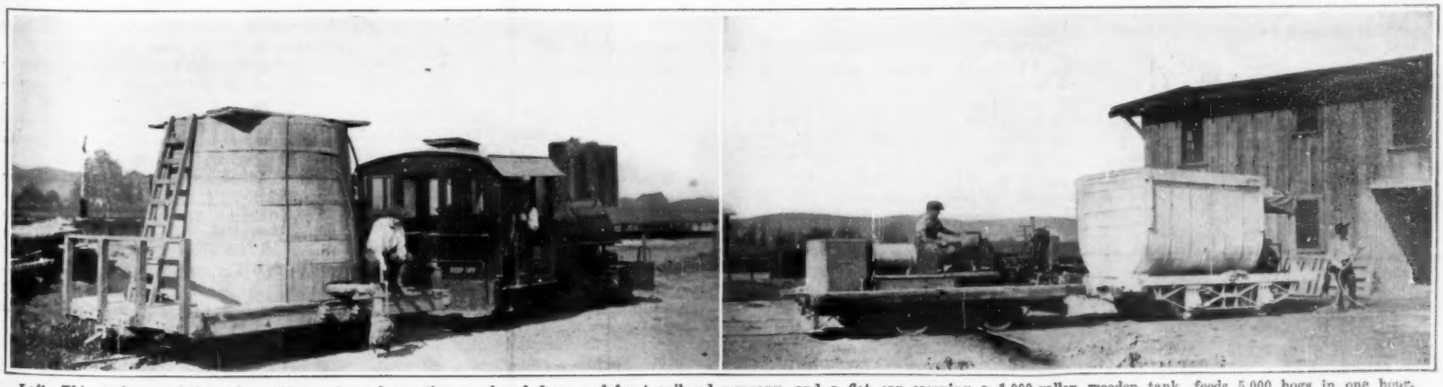
Mechanical Hired Men

THE mechanical genius of a California rancher is responsible for the inception of the most marvelous mechanical system for feeding live stock in use anywhere in the world. Mr. F. E. Lewis of the Diamond Bar Ranch, Los Angeles County, is producing beef and pork on a large scale on his 8,000-acre agricultural project. To simplify the labor involved in feeding the thousands of cattle and hogs which he raises, he is utilizing a novel, miniature railroad system and original inventions in the way of a gasoline locomotive, a special hog-feeding car, extraordinary cattle-feeding cars and a unique car developed especially for the whitewashing of farm buildings and disinfecting of the hogs.

From a defunct railroad company this successful and progressive rancher purchased an 18-ton steam locomotive and 35 small flat cars as well as 5 miles of standard gage track. He so arranged his yards and live stock buildings that space was allowed for the laying of track along all central alleys. His hoghouse which is 1,200 feet long and 26 feet wide is the largest in the world. It has individual farrowing pens for 250 sows. The railroad track passes through the center of this building. Mr. Lewis has devised a special tank feeding car by placing a 1,000-gallon wooden tank on one of the flat cars. He has provided a series of centrifugal paddles in the center of this tank which are kept in motion by a small 5-horsepower steam engine at the front of the car. They keep the feed agitated and well stirred. The locomotive is operated by a pensioned engineer who is too old for active railroad service. The feed is hauled out on the second story platform of the feedhouse and dumped into the top of the tank. Simultaneously a 2-inch standpipe sprinkles water over the feed and reduces it to a sloppy consistency. The mechanical agitator completes the mixing process. The feeding train is then headed at a speed of one mile an hour down the feeding alley. One man operates a special lever which opens and closes a 4-inch extendable hose arm at the bottom of the tank which is equipped with a hooded nozzle and which deposits the feed in the individual troughs in the front yard of each hog. An automatic gate directly over each of these troughs is operated by another attendant by means of a mechanical trip. As the feed is being deposited in each trough which is outside the individual hog lot, the gate is closed and the animal cannot get at the feed. When the trough is full, the attendant trips the trigger and the gate swings out at the bottom and rests against the outside wall of the trough and provides room for the hog to insert its snout and eat. All these operations are done in the twinkling of an eye as the tank car steams slowly along the alley. Mr. Lewis is now working on an automatic method of tripping the different gates so as to eliminate the services of one man on the feeding car. This method permits of two men feeding 5,000 hogs in 60 minutes, a record which promises to stand for many years.

A number of the flat cars are fitted with

(*Continued on page 359*)



Left: This train, consisting of an 18-ton steam locomotive purchased from a defunct railroad company, and a flat car carrying a 1,000-gallon wooden tank, feeds 5,000 hogs in one hour. *Right:* A home-made whitewashing and disinfecting equipment. The flat car carries a large wooden tank of 35 barrels capacity and a four-horsepower gasoline engine which furnishes power to run a number of agitator paddles in the interior of the tank, which stir and mix the solution. The engine also operates a triplex spray pump

Two typical trains employed on a large Californian stock farm for doing more work with less labor

With the Engineers of Industry

A Department Devoted to the Physical Problems of the Plant Executive

This department is devoted to business men, works managers, production engineers, and all other executives seeking the maximum efficiency in carrying on their work. The editor of this department will endeavor to answer all questions relating to plant equipment, factory management, and industrial affairs in general.

Chain Blocks and Trolleys

INCREASED production and economy of labor are the leading factors in present-day commercial success; for, as we are coming to learn by degrees, the world is suffering from a steady inflation of production and selling costs rather than from the sole effects of the Great War. Had the war not taken place as it did, we should have undergone a period of readjustment some five years from now; and since the inflation would have attained greater proportions by then, the readjustment would have entailed all the more hardships.

However, let us come down to specific cases of increased production and economy of labor. The lifting and conveying of heavy loads is still being done by antiquated methods in many of our otherwise progressive plants. Take the first of the accompanying illustrations, for instance. Here is a case containing an air compressor, which weighs 1,850 pounds. Five men are required to push this case along on the usual hand truck. Yet with a chain block and trolley installation, one man can readily handle the same load, thus saving the labor of four men. By means of a spur-geared block or even an electric hoist, the load is quickly hoisted into position and held safely suspended. With the trolley and overhead I-beam system the load can be quickly delivered to its destination. Independent of flooring conditions, up out of the way, the overhead system conserves aisle space, requires less labor and multiplies deliveries many times over other methods.

Such an installation is not unduly expensive, yet it repays its cost many times over in a short space of time. This instance is but typical of the many labor-saving devices which American industrialists must resort to if they are to compete successfully with European industrialists who are working with far less costly labor and who, let it not be overlooked, are daily turning to labor-saving devices in order still further to reduce their production costs.

The old and the new way of handling heavy loads in the plant, showing how the labor of four men can be saved

Fighting the Coal Pile Fire

MATERIAL-HANDLING machines are being used to an ever-increasing extent for the handling of coal. Indeed, it appears that there is perhaps no better way of operating a coal pile than by the use of one or more of these material-handling machines, with their long power-driven belts that can be installed anywhere and placed at any angle for raising coal from one level to another.

Now every user of coal in large quantities knows that this fuel deteriorates if left standing for a protracted period, and that the most practical method of preventing deterioration or even conflagration is to keep the coal stirred up, so to speak. In this connection the material-handling machine has a very definite application. A typical example of this application is that of the Portland Gas Company of Portland, Maine. Two conveyors which they had ordered some time previous, arrived after their storage pile containing 16,000 tons of coal had caught fire. By simply turning over the coal, thus giving it a chance to cool, the two conveyors saved most of it, after fire boats playing salt water through twin nozzles into the fire rendered the permanent installation useless.

Moving the Sectional Steel Building

IN considering the standardized sectional steel building, stress is seldom laid on the ease with which such a structure can be taken down and transported, for the reason that such a feature does not enter into the manufacturer's mind except on rare occasions.

An immense sectional steel building, nearly a thousand feet long, was erected by the U. S. Navy Department at the Ford Shipbuilding Plant, Detroit, Mich. This building has now been taken down and shipped to Hampton Roads, Va., where it is being re-erected as three separate buildings—completely conserving the original structure. In fact, the ease with which this building and other similar structures have been taken down and re-erected with 100 per cent salvage is a strong point in favor of sectional steel buildings.

Hollow Tile and Dry Floors

WITH its non-conducting air cells, its density and low absorption value, hollow tile is said to provide an effective insulating blanket for basement floors of factories. Hollow tile gives a warm, dry floor, which in turn results in a sanitary basement for the factory or home. Moreover, it is economical. The large, light units are easily handled and quickly laid. First, the ground is leveled so that all ridges, lumps or depressions are eliminated. Then a layer of cinders or broken stone is put down and covered with a thin layer of sand. This is all pitched to the floor drains. The tile is then placed on the sand cushion so that it is as firm as when imbedded in the mortar joint in wall construction. These tile should not rock or teeter when walked upon. The surface of the hollow tile floor is thoroughly wetted before laying the cement top coat, which should be composed of one part cement to not over 2½ parts of clean, coarse sand, applied 1 inch to 2 inches thick, depending on conditions.

A Telescopic Hoist for All Jobs

FOR the handling of ash barrels and other refuse there is often need for some form of hoist that is available when wanted, but out of the way during idle moments. Working on the telescopic principle, there has been developed an ingenious hoist which may be used for lowering and raising ash barrels, bags, bales, carboys, parts of machinery and other loads under 1,000 pounds. The upright standard of the hoist may be raised or lowered by means of a hand-operated winch, while the cable, traveling up through the hollow standard and swinging arm, is controlled by an electric hoist.

Weight of Ash and Various Kinds of Coal

IN taking inventory of fuel stocks, or in estimating sizes of bins for a given quantity of fuel, it is often necessary to know the weight of a given volume of a certain kind of coal. The accompanying table which appeared in the *American Contractor*, supplies the needed information in a convenient and concise form.

TABLE SHOWING WEIGHTS OF COAL AND ASH

Material	Weight in lbs. per cu. yard	Volume of 5 tons in cu. yards
Ash, clinkers and cinder	1,700	2.35
Coal, anthracite, lump	1,875	2.13
Coal, anthracite, broken	1,782	2.24
Coal, anthracite, egg	1,753	2.28
Coal, anthracite, stove	1,736	2.3
Coal, anthracite, chestnut	1,693	2.4
Coal, anthracite, pea	1,646	2.43
Coal, bituminous	1,500	2.66
Coal, Cumberland	1,450	2.76
Coal, cannel	1,360	2.94

Why Mechanical Stokers Pay

COMBUSTION rates up to 60 or 70 pounds of coal per square foot of grate per hour are now attained in stoker-fired plants, and single stokers with areas of 150 to 200 square feet are now in operation. It is this high combustion rate and large grate area, together with modern ash-handling equipment, that has made possible the economical operation at high ratings of the large boilers now becoming common. Ash disposal is one of the important problems to be met in the operation of large units. It has been estimated that the ash content of coal burned under boilers in 1920 was from 10 to 20 per cent greater than in previous years, this increased ash causing much difficulty and, in some instances, limiting the boiler output.

Better Glass for Daylight Lighting

KNOWING the importance of greater conservation of daylight, research work of a leading wire glass manufacturer has been directed toward the production of glass with high diffusing power. Since great areas of the side-walls and roof of modern factories are built with steel sash and glass, it has been the aim of this manufacturer to provide a glass that would handle daylight to the best advantage.

The result is in the form of a new wire glass, every square inch of which has 900 prisms that appear like tiny corrugations. Their shape and size have been scientifically determined to promote diffusion. The United States Government used over 100,000 square feet of this new glass for a single building, and the new glass is attracting much attention wherever it is being introduced.

Some Causes of Accidents

A STUDY of the causes of 220,707 accidents which have occurred in the plants of the United States Steel Corporation shows that but 4.94 per cent of the total number, excepting those in connection with overhead electric cranes, were due to machinery causes. While no doubt this very low percentage is the result of the protection afforded by the mechanical safeguards installed by the subsidiary companies of the corporation, the accidents represented even by this low percentage do not indicate that the machines were not properly guarded, for employees do get hurt through their own carelessness even though the machines are equipped with safety devices.

Hand labor caused 44.42 per cent or nearly one-half of all these accidents. The conditions under which these accidents occur are almost wholly within the control of the workmen and are due largely to their carelessness. In analyzing the causes of any 100 accidents it will be found that at least 90 of them might easily have been prevented.

Aside from the 44.42 per cent caused by hand labor, the corporation's records indicate 4.94 for machinery, 14.76 per cent for the mines, 4.26 for railroads, 7.13 for burns, 5.10 for eyes, 8.09 for falls, and 11.30 for all other causes.

Bringing the Wood-Burning Locomotive Up to Date

WE are apt to think of wood-burning engines as of the days "before the war" (the Civil War, of course) and, as a matter of fact, they practically disappeared during the late seventies. At the present time a few are running in this country, but they are mostly in lumber camps where coal is not available.

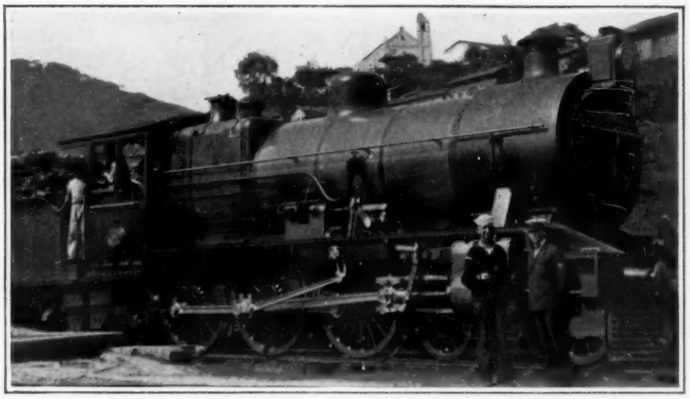
The scarcity of coal which has prevailed during recent times has been a serious problem to many railroads far removed from the mining centers, and, in the case of some South American countries, where coal has to be imported, the employment of a substitute fuel has become imperative.

The management of the Sao Paulo Railway of Brazil has met the situation by what might appear a step backward, but which is, in reality, a bold and practical solution of the problem.

The accompanying illustration shows a remarkably handsome and well designed locomotive now hauling fast passenger trains between Sao Paulo and Rio de Janeiro. It is of the 4-6-2 or "Pacific" type, and the neat appearance and high finish of the engine are strongly suggestive of British practice.

There is no outward indication of the engine being a wood burner, except that the tender is stacked high with the necessary fuel. The extension smoke box is provided with a spark arrester so that no change in the shape of the smoke stack has been necessary. The present writer remembers the enormous "balloon" stacks on our old wood burners. The diameter of these stacks sometimes rivaled that of the boiler, and, as their spark catchers were more or less inefficient, they scattered showers of bright sparks on the adjacent land, causing many fires. Some old railroad men who were firemen on wood-burning engines in bygone days are still living. They affirm that, with small fire boxes and short boilers, these engines blew out much fuel at the stack, which emitted not only sparks but flame, causing the top of the smoke box to become red hot. Furthermore, when hauling a heavy train the fireman's job was a laborious one, as the fuel burned away rapidly and the fire box had to be kept literally filled up to the fire door. It was often necessary to employ an assistant fireman known as the "wood passer" whose duty it was to carry the wood from the tender and pile it on the deck ready to the fireman's hand.

But with a modern locomotive fitted with a water-tube and fire brick arch and a correct proportion of boiler and fire box, there should be no serious waste of fuel; so that the task of firing the Sao Paulo engine under notice is not so laborious as would naturally be expected.



Wood-burning locomotive that hauls fast passenger trains between Rio de Janeiro and Sao Paulo, in Brazil

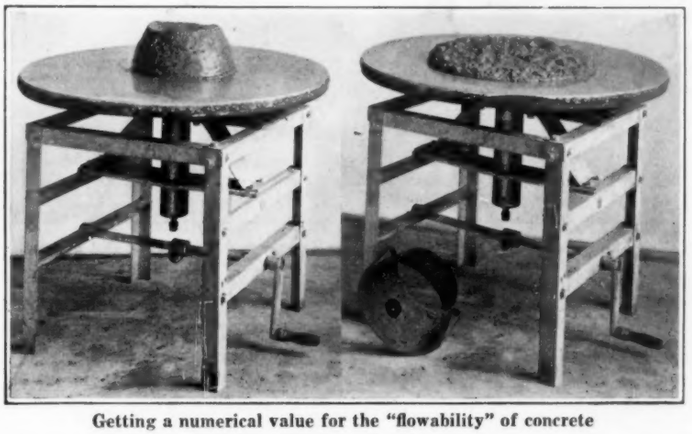
Measuring the Flowability of Concrete

FOR determining the flowability of concrete or mortar mixtures to a more certain degree than mere estimating by eye, judgment or feel, a device has been perfected by the Bureau of Standards. This consists of a metal-covered table top which can be raised vertically by a cam working at the end of a vertical post. The table top is attached to the top of this vertical post. A bolt at the lower end of the shop regulates the height of the drop.

In measuring flowability of a given mixture of concrete a mass is molded at the center of the table in a sheet-metal mold. The mold has the shape of a hollow frustrum of a cone. By slight tamping the mass completely fills the form and the form is withdrawn. By dropping the table 15 times through a distance of ½ inch the mass is flattened and it is usually found that it spreads concentrically. In making the measurement to compute the flowability two diameters at right angles to each other are measured. If the difference is apparent the long and short distances are measured. A self-reading caliper is used and it is graduated so that the sum of the two readings is the value for flowability. The value may also be calculated by dividing the diameter of the new mass by the diameter of the original mass before agitation and multiplying by 100.

This device will accurately measure consistency of a concrete, mortar, cement or lime paste for all consistencies varying from dry masses having a slight tendency to flow or change shape when acted upon by external forces, to those which are so fluid that water will flow away from the coarse aggregate.

How reinforced bars are being used on the concrete roads of California



Getting a numerical value for the "flowability" of concrete

The Reinforced Concrete Road

FORTY miles of concrete roadway has been laid recently in experimenting with the use of reinforcing bars. The concrete base is reinforced with ⅜-inch deformed square steel bars which are placed transversely on 18-inch centers. For the minimum outlay of steel this size and spacing meet the requirements of maximum bond across the longitudinal cracks, if any cracking occurs. It has been found that shoulders of roads as narrow as the 15-foot widths which are being laid so widely in California now are worn down quite rapidly. Where transverse cracks reach the edge of the road it has been found that triangular sections will ravel out. By using a longitudinal run of ⅜-inch bars these points are strengthened. These longitudinal rods are laid with the joints alternately butted and lapped and the butt joints are brought half way between the adjacent transverse reinforcing bars.

These reinforcing bars are placed in the center of slab and several ways have been tried such as thrusting them down from the top or pulled up from the bottom where they were laid before pouring. The most satisfactory method so far used is by supporting the bars at the proper height by short lengths of pipe and the pipe is withdrawn as the concrete is poured. On a 15-foot pavement two short sections of 2-inch water pipe for supporting the steel rods at approximately one-third of the distance from each edge are used. These sections of pipe are fastened to the concrete mixer by wire or chain and the mixer moving along pulls the pipes also.

The longitudinal rods are supported by hooks hung on the headers or by short pieces of 2 by 4 in which a slot is cut which holds the rod at the proper height and distance from the edge of the pavement. The wood blocks are moved along as the paving progresses. The ends of the transverse rods are bent and hooked over the longitudinal bars and securely wired. On wider pavements than the standard it is customary to use four sections of pipe fastened together in a rigid fan shape arrangement so that the rods will be held in position until the concrete is poured.

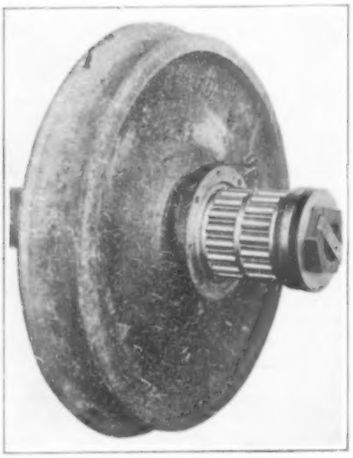
Car barn one story high, with the floor of the future second story serving as the roof

Making the Future Floor Serve As Temporary Roof

THE construction shown in the accompanying view is typical of what is being done throughout the country under present conditions, namely, building with a view to the future. Here is a car barn building one story high, with a roof that is to constitute the floor of the second story when traffic requirements warrant the building of a second story. It will be noted that this floor will be arranged in the form of pits, permitting workmen to get under the cars, and that the concrete reinforcing rods are arranged in rows to form the pits and track supports. In the meantime the concrete has been given a waterproof coating to make the temporary roof impervious to rain.

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Arts



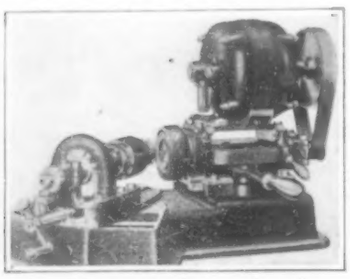
Applying special roller bearings to the axles of railroad cars

Saving Railroad Power with Roller Bearings

THE high operating costs of our railroads today have undoubtedly prompted an inventor to suggest the use of roller bearings as shown in the accompanying illustration. This special roller bearing, attached to the end of the usual car axle, obviously reduces friction to a marked extent. In fact, the inventor claims that a train equipped with such roller bearings effects a saving of 50 per cent in the motive power required, but this seems to be an extravagant claim. At any rate, a car equipped with such roller bearings and representing a load of sixteen tons, was pushed along by one man during a recent demonstration. Another advantage of this device is that the axles become self-lubricating, avoiding hot-box troubles.

Automobile Valve Grinding by Motor

WE illustrate a very convenient motor-driven valve-grinder which ought to take a good deal of the trouble out of this troublesome operation. It will be seen that, facing the grinding tool, the machine carries a circular chuck with a hole in it. The valve-stem goes through this hole, and is held in place by turning the knurled screw on the far end of the chuck, almost hidden from view in the picture. Then by means of the scale on the little table that carries the chuck, and a notch on the upper surface of the semi-circular protuberance from the stand, the machine is set for any desired angle and will grind the valve accurately to this angle.



A quick, easy and accurate valve-facer

A Radio Receiver for Everybody

FROM France comes the tiny radio receiving set shown in the accompanying illustration. This receiving set consists of a telephone receiver of the watch-case type, on the back of which is mounted a multi-contact crystal detector, as well as a collection of accessories.

The diminutive receiver may be connected by means of the flexible leads normally wound on flat spools, to any object that is at all suitable as an aerial, and to a "ground." A fixed condenser, shown at the right, may be connected in parallel or in series with the telephone and detector combination, so as to vary the wave length of the receiving circuit. However, it is well to mention the fact that a simple receiver of this kind operates on a broad wave length; that is to say, it receives signals of all wave lengths within wide limits.

The multi-contact detector, contained in the brass casing on the back of the telephone receiver, is an ingenious device. Ten fine wires press on ten different spots of a galena crystal; and the ten wires are connected to ten contact points of a switch. By turning the switch from one contact to another, a different "spot" is selected, until the best "spot" is found. By unscrewing the brass casing cap and turning the cup containing the galena crystal, ten new "spots" may be brought into play. The tension on the crystal may be varied by turning the brass casing collar.

Copyright, Kadel & Herbert

Complete radio receiving set especially intended for jewelers and others interested in receiving time signals from Government stations

This simple receiver is especially intended for the reception of time signals by jewelers and others interested in accurate time. Radio stations throughout the world are sending time signals day by day, which may be intercepted over a wide area because of their great power. Such signals are simple and do not require a knowledge of the code.

Omnibus Stability

ONE riding as a passenger on the top of one of the double-decked buses used in New York and London may sometimes feel that he occupies a dangerous position should the bus tip over. The chances of this occurring have been analyzed recently in a British publication, *The Engineer*, and the conclusions reached in the article, of which this is a digest, should give the passenger who likes to take the breezes from the top of a bus considerable satisfaction.

Taking the ordinary design of motor omnibus used on the London and New York streets, we find that it is a vehicle weighing, in service condition, some 9,150 pounds, of which weight a little over 64 per cent is in the chassis. It is capable of carrying, without overcrowding, thirty-six people, representing, on the average, a load of 5,400 pounds, so that when fully laden the vehicle and those on it weigh something in the neighborhood of 6½ tons. Its center of gravity, in service condition, but without load, lies low down, being only about 44½ inches above the road surface, or just a little above the level of the tops of the rear wheels. The gage of the wheels being 70 inches, it follows that the vehicle will recover itself if it is tipped up until the rear axle is lying at 39 deg. to the horizontal.

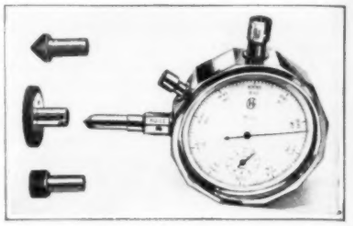
When the omnibus is fully loaded the center of gravity rises to 62 inches above the road surface, so that in this condition the maximum heel from which the vehicle will recover itself is 29½ deg. These figures do not take account of the fact that the body is mounted flexibly on the chassis. In an actual test the yielding of the springs permitted the vehicle to be tipped, when empty, until the center line of the body was inclined at 46 deg. to the verticle. It will be seen, then, that the stability of a motor omnibus empty or fully loaded is considerable when vehicle is stationary.

When the omnibus is in motion the angles of heel mentioned above are a measure of its stability so long as its course is a straight line, and indicate the magnitude of the "bump" in the road required to upset the vehicle. Thus the wheels on one side of the omnibus could rise off the road surface nearly 3 feet without entailing the upsetting of the vehicle. Bumps of this description can be ruled out of consideration.

The critical test for the stability of the vehicle arises, of course, when centrifugal force comes into play during the rounding of a corner. Taking 30 feet as the radius of the curve and 7 miles per hour as the speed when rounding the corner—both figures being on the severe side—the upsetting force on the fully loaded omnibus works out at 7,915 lb./ft. The righting moment of the vehicle is 42,430 lb./ft.

A Speed Indicator Combining Stopwatch and Revolution Counter

A NEW YORK manufacturer has developed a device for counting speed over a period of three seconds which integrates the result and gives the information sought in terms of revolutions per minute or yards per minute. The timing, by use of this device, is obtained automatically. After connection has been made with a machine, all that is necessary to obtain a reading is to press a large button. When the contact is made with a shaft the spindle of the instrument runs freely until the button is pressed down and released. The spindle is automatically freed after the device has run three seconds and the hands remain in the reading position. By pushing a small button the hands may be brought back to zero.



Pressing the button gives the reading with this speed counter

The instrument can be operated in any position and has a range from 1 to 10,000 revolutions per minute. The long hand indicates speeds from zero to 1,000 revolutions per minute and the short hand running over a separate dial counts the number of thousands. Either revolutions per minute or yards per minute may be read directly on the dial without requiring any mathematical calculations. Both the large and small dials have a second set of graduations in red to indicate speeds in yards per minute.

Keeping the Trousers in Correct Shape

FROM England comes the simple yet effective idea shown in the accompanying illustration. This device, intended to keep trousers in a smart condition, as our English friends put it, is the invention of G. Parnell, an ex-service man. It is made of featherweight rust-proof metal, and fits into the cuffs of the trousers, giving them the correct Bond Street set-up over the shoes. This device appears to be a fit companion to other devices of the same category, intended to give a definite shape to soft hats and also to coat collars.

A device which fits into trouser cuffs and gives the trousers the proper shape

American Lignite Coals

(*Continued from page 344*)

binder will not stand storage and handling. On the other hand, briqueting the untreated lignite with a binder is commercially prohibitive because of the expense involved in view of the low grade of the raw fuel. It was because of this that a system of drying and carbonizing had to be developed which would produce a substance lending itself readily to processes of briqueting.

The carbonized lignite is said to bear somewhat the same relation to the original material that charcoal does to wood, and the resultant coke contains about double the amount of fixed carbon that would be found in a like quantity of raw lignite. Therefore, with its combustion value thus improved the coke justifies the price of a suitable binder.

The practice is to mix the carbonized material with a binder and then to subject it to compression in a briqueting machine. In this condition, however, the briquets are not waterproof, and to make them so they are heated sufficiently to cause the binder to coke. The Canadian investigators have spent a good deal of time in fixing upon a suitable binder, because they recognize that this factor would be an important one in making the whole undertaking industrially practicable.

Coal-tar pitch is an excellent binder, but that substance is by no means cheap in Canada, and the amount available there is rather limited. Sulfite pitch, produced in the manufacture of paper pulp, is at hand in immense quantities. This liquid is generally discharged as waste into the waters near pulp mills, and has been responsible for the poisoning of the fish in the streams. This pitch provides a thoroughly satisfactory binder.

The Canadian Research Council sapiently pointed out three years ago, before the Lignite Utilization Board became active, that the road to success in the briqueting problem is strewn with the wrecks of ill-conceived attempts to do this apparently simple thing—failure resulting from either ignorance of what had been done, lack of technical experience, or shortage of money. Therefore, the Lignite Utilization Board obtained the generous appropriations already mentioned, and with this fund in hand, and with a wealth of expert assistance, it was relatively easy to settle upon a proper line of procedure and then to start the erection of a plant of ample capacity to operate on a commercial basis. The Board intends to distribute its output through the ordinary channels of trade even though working as a governmental institution. As explained officially, "In its relation toward business interests, the Board has the power of an incorporated company to buy, sell, make contracts, hold property, etc. In its relation to the Government, it is a trust, holding and expending funds provided by the Government, and having power to hold property in trust."

The factory at Bienfait would have been in full swing months back had not delays been encountered in connection with the delivery of machinery and building materials. Even so, the chairman of the Board, Mr. R. A. Ross, reports that the works will be producing briquets by the beginning of the coming summer. This example on the part of our neighbors to the north should prove heartening to us, and no doubt will serve to strengthen the hand of the U. S. Bureau of Mines in its ceaseless endeavors to open up new sources of fuels within our continental limits. Two years ago the Bureau stated that the nation's coal resources of all ranks totaled 3,553,637,000,000 mineable tons of 2,000 pounds, of which 1,051,290,000,000 tons, or nearly one-third, consisted of lignite. Of this lignite 964,424,000,000 tons lie in North and South Dakota and northeastern Montana, while approximately 23,000,000,000 tons are in Texas, 7,404,000,000 tons are in Alaska, and relatively smaller quantities are in several of the other western and southern states. Plainly, if these so-called low-grade fuel deposits can be transformed into briquets substantially the equal of a corresponding weight of anthracite coal, surely this metamorphosis should be encouraged in every possible way.

The fact that should be held continually in mind is that our lignite deposits are commonly found in those parts of the country where no other solid fuel exists. The average analyses of some of our lignites give the following values:

	Arkansas	Texas	North Dakota
Moisture ..per cent	29.73	28.63	27.13
Volatile hydrocarbons " "	37.87	32.53	29.11
Fixed carbon " "	23.95	30.43	36.16
Ash ..... " "	8.45	8.41	7.60

The Alaska lignite closely resembles that of Texas and North Dakota, and the sulfur content of the lignite in these fields rarely exceeds 1 per cent. The average heating value is about 7,500 British thermal units per pound. The Arkansas lignite is distinguished from the others principally by a higher percentage of volatile matter, which yields large quantities of oils and tars.

Fuel conditions in so-called western Canada are not radically dissimilar from those prevailing throughout our own lignite-bearing States, into which we ship yearly millions of tons of bituminous and anthracite coals. As the Bureau of Mines expresses it, the procedure is "literally an example of 'carrying coals to Newcastle.' The results are high prices for both industrial and domestic fuel, the imposition of a great handicap on the industrial development of these regions, the tying up of much transportation equipment needed for other service, and other economic lost motion. The problem therefore involved in the utilization of lignite is not a local but a national one."

Finally, by way of emphasis, the Bureau shows what is happening in the territory naturally tributary to the Dakota lignite deposits. Into this region something like 2,000,000 tons of bituminous coal is shipped annually from Illinois, Indiana, West Virginia, Kentucky, and Pennsylvania. The average haul is about 1,000 miles.

If the lignite in the Dakotas and Minnesota were put into stable and serviceable condition, by means of carbonizing and briqueting, the fuel demand could be supplied with an average haul of less than 400 miles. Two years ago the freight rate was about four mills per ton-mile. On the face of it, if the fuel and power requirements of the area in question were supplied from the local lignite mines there would be a yearly saving on freight alone of quite $4,800,000! And if this near-by fuel were used in place of the anthracite and bituminous coals brought from other States, the movement of 1,200 engines and 50,000 cars would be avoided. The rail-tonnage referred to does not, of course, include the carriage of 1,500,000 tons of anthracite which makes a goodly part of the trip to this region by way of the Great Lakes.

The Bureau of Mines has at its disposal an appropriation of $100,000 for the investigation of lignite utilization, and New Salem, North Dakota, has been selected for the site of a Government plant for large-scale carbonizing and briqueting tests. This allowance seems inadequate in view of what Canada has done to provide for the needs of a far-less densely populated section. Here in the United States the transportation of coal and its widespread distribution invite reflexes of a grave economic character concerning probably twelve times as many people as in the case of the Dominion.

ECONOMICAL PRODUCTION

ECONOMICAL production is, perforce, the objective of the manufacturer, for on it depends, ultimately, his ability to meet the insistent demand for lower prices.

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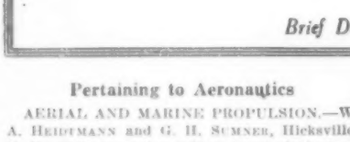
St. Catharines, Ontario

Recently Patented Inventions

Brief Descriptions of Recently Patented Mechanical and Electrical Devices, Tools, Farm Implements, Etc.

Pertaining to Aeronautics

AERIAL AND MARINE PROPULSION.—W. A. HEIDTMANN and G. H. SUMNER, Hicksville, N. Y. This invention relates particularly to a propeller of the combined airplane and helicopter type. The purpose is to provide a propeller



A FRAGMENTARY FRONT ELEVATION OF AIRPLANE WITH INVENTION APPLIED

which is designed to lift an airplane or other vehicle to which it is applied during a portion of its movement, and to propel it forwardly during another portion of its movement, and to produce a propeller which is capable of driving an airplane at greater speed with less expenditure of motive power than is usual.

Electrical Devices

ELECTRIC LIQUID HEATER.—B. W. MACY, 409 E. Bay St., Jacksonville, Fla. The object of this invention is to provide mechanism of the character specified capable of heating liquid quickly to a very high degree wherein a heating coil is provided embedded in an agent capable of being heated to a high degree in a short time by the current through the coil.

ELECTRIC HAIR SINGER.—J. P. MCMAHON, 15 11th St., Whitestone, L. I., N. Y. The object of the invention is to provide a hair singer using an electrically heated wire

A PLAN VIEW OF THE SINGER WITH PARTS BROKEN AWAY

as the singeing medium to insure a quick and effective singeing of the hair. Another object is to provide a simple construction and arrangement to prevent short circulating through the medium of the hair or scalp.

Machines and Mechanical Devices

WIND MOTOR FOR AIR PUMPS.—G. YANACOPOULOS, 621 E. 161, New York, N. Y. The invention relates to a power machine which is associated with various other devices in a complete assemblage whereby electrical energy is produced therein. Among the objects is to provide a particular form of windmill which may use all of its power in providing a supply of compressed air for a storage tank which is associated with an air engine and a generator whereby it may be utilized to produce electrical current either for immediate use or for charging a storage battery.

AUTOMATIC DOUGHNUT MACHINE.—C. A. PURDY, 931 Lakeside Place, Chicago, Ill. An object of the invention is to provide an automatic machine which is adapted to be connected with a suitable prime mover, whereby the doughnuts are formed, dropped into a container, immersed in boiling oil or the like until done and then deposited in a receiving pan without any manual action beyond the placing of the dough in the hopper of the machine.

APPARATUS FOR TREATING CINNABAR ORE.—A. J. CARVER, Leland, Oregon. More particularly this invention relates to a construction of retort and condenser which cooperate in the recovery of mercury from the ore, an object being to provide an apparatus of the character stated, which facilitates the recovery of the mercury or other material and which economically performs the operation. A further object is to provide means for heating the ore while in a finely divided state.

COMBINED PRESSURE REGULATING AND GOVERNING APPARATUS.—J. P. METZGER, Carlstadt, N. J. This inventor has been granted three patents of a similar nature, the object being to provide an automatic pressure regulating and governing apparatus arranged to insure the accurate functioning of the apparatus as a regulator, and after it has been set to a predetermined pressure, and to provide a governing function for coordinating or subcontrolling the regulator without interfering with the accuracy thereof in the performance of its work as a regulator. Another object is to render the apparatus exceedingly sensitive and dispensing entirely with packings, glands, stuffing boxes and other devices producing frictional resistance. A further object is to provide a combined pressure regulating and governing apparatus arranged to act as an automatic pressure regulating valve or as an automatic stop valve or as an emergency stop valve.

BOBBIN UNWINDING ATTACHMENT FOR SEWING MACHINES.—E. M. MENZL, cor. Riker and Steinway Ave., Steinway, Long Island City, N. Y. The invention has particular reference to bobbin winding and unwinding devices. Among the objects is to provide a means or attachment for the bobbin winding spindle adapting the same to receive any convenient empty spool upon which the thread may be readily wound mechanically by operation of the machine.

COMBINED MOTION PICTURE CAMERA AND PROJECTOR.—F. MLADINICH and A. R. DE TARTAS, Rockville Center, N. Y. Among the objects of the invention is to provide a combined photographic camera and moving picture projecting apparatus of such nature as to adapt it for ready and satisfactory use by an amateur. Another object is to provide such a camera suitable to be carried by tourists in place of an ordinary camera, the apparatus being small and adapted to be manipulated for the purpose of photographing animated pictures and suitable with but slight changes for the projection of the pictures at any time after the development of the film.

SHEET METAL PRESS.—D. C. CANFIELD, East Canaan, Conn. The particular object of this invention is to provide a press adapted to form the ends of sheet metal drums, cans and receptacles in general, and for properly crimping the same. The invention aims to provide mechanism in which the receptacle will be firmly held in position and be operated upon to crimp or otherwise form the end of the same.

SLICING MACHINE.—A. G. ALBERTI and A. B. BARON, 2 Quai de la Rapee, Paris, France. The invention has for its object a machine adapted for cutting ordinary meat, sausage, ham, etc., into slices of determined thickness. The machine is essentially characterized by a frame carrying a circular knife, the to-and-fro motion of which produces the rotation of the knife and determines the forward movement of the carriage carrying the product to be cut.

SICKLE GRINDER.—L. V. SONNER, R.F.D. No. 1, Buhe, Idaho. The purpose of the invention is the provision of a grinder having simple means for rigidly supporting the sickle blade in convenient position, and driving means for a grinding element which permits of the universal movement so that it can be moved to any desired position with respect to the sickle blade for effecting the desired grinding of the teeth of the blade.

Medical Devices

ORTHODONTIC APPLIANCE. — J. E. JOHNSON, 716 Starks Bldg., Louisville, Ky. The object of this invention is to provide a device which positively holds and constrains an arch-bar to perform its orthodontic function which does not interfere with occlusion and does not discomfort the wearer which is universal in action and application and which is easy and inexpensive to manufacture.

DENTAL FLOSS HOLDER.—L. J. HOGARTY, 144 S. Oxford St., Brooklyn, N. Y. The object of the invention is to provide a dental floss holder for professional or personal use, and arranged to enable the user to quickly place a piece of floss in stretched position and allow of readily removing the same after use. Another object is to permit the ready removal of extraneous matter from between teeth or to apply a ligature or perform other dental operations without passing of the fingers into the mouth.

Prime Movers and Their Accessories

TIMER.—H. ZINS, Wabasso, Minn. This invention has for its object to provide mechanism for use in connection with timers of internal combustion engines, for permitting the timer to be arranged above the engine in convenient position for inspection, while at the same time providing the proper drive connection between the timer and the time shaft.

PISTON VISE.—L. A. ANDERSON, Box 57, Kasson, Minn. The invention relates to devices for holding pistons of internal combustion engines and the like. An object is to provide a piston vise by means of which equal pressure is applied to all sides of the piston, thereby holding the latter rigidly without the slightest distortion. A further object is to provide a vise by means of which different sizes of pistons may be rigidly clamped.

Railways and Their Accessories

LATCHING DEVICE FOR CAR COUPLINGS.—T. H. SANFORD, Alexander City, Ala. The invention relates to latching means for effectively securing the draw-heads of the couplings together so as to prevent their accidental release and to eliminate the unnecessary slack which is usually found in couplings. It is also a purpose to provide a device which in its released position is capable of being moved to a locking position when the two draw-heads are moved into engagement.

AUTOMATIC RELEASE VALVE. — G. H. SAUTIER, 6438 S. Honore St., Chicago, Ill. An object of the invention is to provide an automatic release valve adapted to be connected to an auxiliary reservoir in an air brake equipment of standard type which will automatically close when the air in the auxiliary reservoir has been exhausted. A further object is to provide a device which will normally remain closed, thus preventing escape of air.

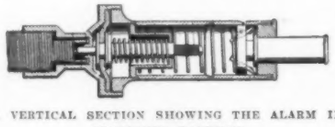
CAR DOOR ACTUATING MECHANISM.—W. N. MCCLELLAN, 430 Cumberland St., Brooklyn, N. Y. The invention primarily contemplates a means for controlling the entry and exit of passengers to and from a car, said means being operable from a common control point located within convenient reach of the motorman. An important feature of the invention is to provide a safety device for reducing the possibility of accidents to a minimum. Another object is to provide an efficient fare-collecting means which controls the exit passage of the car.

Pertaining to Vehicles

TRUCK.—R. A. BRADLEY, Box 102, Merritton, Ontario, Canada. The particular object of the invention is to provide a truck for conveying crushed stone, coal, sand, and other similar material, and to facilitate the unloading thereof by providing on the truck body an outlet chute connecting with an opening in the bottom of the truck, through which the material is fed by gravity, and controlled by the arrangement of a gate.

RESILIENT WHEEL.—C. O. PROWSE, 245 W. 55th St., New York, N. Y. This invention has for its object to provide a construction in which the resilient elements are arranged to be brought under tension when the wheel is rotated in either direction. A further object is to provide a resilient structure for a wheel with protecting means so that dirt and dust will not interfere with the proper operation of the respective parts.

LOW PRESSURE ALARM FOR PNEUMATIC TIRES.—W. A. HARRIS, 238 John St., Greenville, S. C. The prime object of the invention is to provide a device readily attachable to the valve tube of a pneumatic tire and operable to sound a signal upon fall of pressure a predetermined number of pounds below the pressure within the tire when the alarm is connected therewith. The alarm embodies an audible as well as a visible signal; the device is protected against dirt, water or the like.

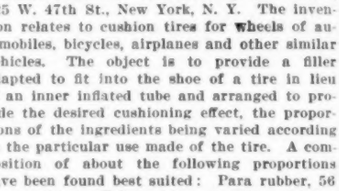


A VERTICAL SECTION SHOWING THE ALARM IN SIGNALING POSITION

COMBINED AUTOMOBILE BUMPER AND TOOL CARRIER.—J. H. DWORK, 217 W. Kenny St., Newark, N. J. The purpose of this invention is to provide a bumper of simple construction which is adjustable laterally to permit its application to automobiles having chassis of various widths and so designed as to support a receptacle in which tools or the like may be carried, such receptacle being formed to allow of the lateral adjustment.

TIRE FILLER.—V. CUTTITTA, c/o Janitor, 525 W. 47th St., New York, N. Y. The invention relates to cushion tires for wheels of automobiles, bicycles, airplanes and other similar vehicles. The object is to provide a filler adapted to fit into the shoe of a tire in lieu of an inner inflated tube and arranged to provide the desired cushioning effect, the proportions of the ingredients being varied according to the particular use made of the tire. A composition of about the following proportions have been found best suited: Para rubber, 56 lbs.; whiting, 27 lbs.; lithage, 13 lbs.; sulfur, 3 lbs.; ammoniac carbonate, 1¼ lbs.; coal tar, 1¼ lbs.

CUSHION TIRE.—J. C. BUSCHE, 318 Hastings St., Detroit, Mich. The object of this invention is to provide a tire having the resiliency of a pneumatic tire without its liabil-



DETAIL OF A PORTION OF THE WHEEL

ity to injure, wherein the tread of the tire is composed of spaced connected tread blocks which are mounted to yield toward and from the hub.

AUXILIARY AUTOMATIC SEAT.—R. H. DIETRICH and T. L. HIBBARD, c/o Le Baron, 2 Columbus Circle, New York, N. Y. Among the objects of the invention is to provide an auxiliary seat arranged to permit of conveniently moving it into extended position for use or folding it into compact form and storing it in a comparatively small storage space in the front seat of the vehicle.

AUTOMOBILE HOOD FASTENER. — A. SMITH, address Asa E. Reed, Hadsell Bros., Worcester, N. Y. An object of the invention is to provide a construction of spring catch and mounting therefor, which can be moved to unlocking position and held in such position until released and then elastically spring into locking position. A further object is to provide a device which will be simple, strong and durable in use.

TRANSMISSION LOCK FOR AUTOMOBILES.—J. S. MICHAEL, Aberdeen, Md. The invention relates more particularly to a simple, convenient and efficient mechanism which will involve minimum change in and addition to the conventional automobile transmission and which will automatically act by a simple movement of the gear shaft lever beyond one of its normal limits of movement in such a way as to lock the propeller shaft or as to prevent towing of the vehicle and at the same time permit the engine to be started and freely operated without danger of stripping of gears.

Designs

DESIGN FOR AN AUTOMOBILE BODY.—A. DE VELASCO, 1 W. 34th St., New York, N. Y.

DESIGN FOR A TOILET BOX.—J. ROSENFIELD, 225 Hooper St., Brooklyn, N. Y.

We wish to call attention to the fact that we are in a position to render competent services in every branch of patent or trade-mark work. Our staff is composed of mechanical, electrical and chemical experts, thoroughly trained to prepare and prosecute all patent applications, irrespective of the complex nature of the subject-matter involved, or of the specialized, technical or scientific knowledge required therefor.

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Recruits for the World's Biggest Fish Show

(*Continued from page 345*)

such a very human look that visitors go into peals of laughter when they witness his antics. Then there is the mud puppy, a dog of the deep. With a set of curious hind legs to match those up in his bow, this specimen might pass as a marine version of the dachshund.

The crew of the "Seahorse" have also been fortunate in securing some good specimens of that curious marine dweller, now rather rare, known as the seahorse. Really it looks more like an interrogation point than a genuine equine. In very olden days, folks believed in the existence of a seahorse of tremendous size, and artists with active imaginations made pictures of him, snorting on the waves. This little fellow is all that is left of him. Something in the pose of his head suggests that seahorses once wore checkreins.

One of the most vital needs of an aquarium such as New York's is proper apparatus for procuring its living exhibits, as dealers in live animals offer nothing suitable for such an institution. The interest and value of its exhibits depend entirely upon its success in capturing and transporting specimens in good condition. The method employed in transporting is quite as important as that employed in capture, since specimens must arrive in such condition as will insure their survival in captivity. In the transportation of fresh-water stock, the rough treatment involved in the use of shipping tanks, wagons and trains, is unavoidable, but in the case of marine stock, better methods are now available.

The director of the Aquarium has always felt that a boat with a water compartment has been urgently needed for this purpose, and has often urged its purchase. A public aquarium without a collecting boat is in about the same situation as a farmer would be without a wagon.

It was not until recently, however, that the Executive Committee of the Zoölogical Society finally authorized the construction of a well-boat to be used in making collections of fishes and marine invertebrates for the Aquarium.

In making collection of fishes in local waters the Aquarium is not entirely restricted to northern species. The Gulf Stream, that great river of the ocean, brings north every summer a host of tropical fishes, some of which have been recently brought in by the "Seahorse." The collecting field, since the installation of the boat, has been extended to such a degree and the work facilitated to such an extent that the Aquarium will soon be able to secure and exhibit something never accomplished heretofore, the majority of the two hundred or more species of fishes known to frequent the shores of Long Island.

What Happens to Ground Water and Why

(*Continued from page 345*)

a 30-day test. Not including sandy lands, the volume of water necessary to move the moisture the first inch was about the same or slightly less than the requirements for conveying the last inch on a basis of 30-day tests. The difference in the percentage of moisture discovered near the bottom and that found near the top of a vertical soil column is cause for inference that more water to the inch is removed for the bottom inches than for the top ones.

The experiments indicated that in the event of flumes being inclined downward water attracted into the soil column appeared, after several days, as free water dripping from the flume, thereby constituting what is technically described as a "capillary siphon." The formation suggests that where a canal is located along a hillside water may be drawn out by capillarity continuously, resulting in the water-logging of land farther down. Topsoil of high capillary power and an impervious subsoil, both sloping downward from a canal at an angle of 15 degrees or more are conditions inviting the waterlogging of the land. A swift, unexpected change in the slope of the ground would produce a swampy area. The lesson the test would teach is so to locate canals as to avoid a repetition of this condition.

Columns of soil encased in specially built flumes, each containing one plate-glass side, were a unit of the equipment used in recording the rate at which moisture travels. The word "flume" as applied to these experiments signifies the soil column and its containers, one side and the bottom of each flume being constructed of wood with metal lining. A feature of the government tests was the use of inclined columns. The soil columns employed were 100 square inches in cross-sectional area, considerably larger than columns used in previous tests. Uniform soil was packed into the flumes and wicks extended from within the water in the tanks up into the flumes, measurements being taken daily and often more frequently.

The flume contained that portion of the soil column extending beyond the outer edge of the ell. The bottom and one side were constructed of 2-inch redwood plank, lined with galvanized iron. The other side was composed of plate glass, the top of the flume being open or covered with maltoid roofing. In area, the soil column and its container was 10 by 10 inches, and of varying lengths. The galvanized lining at intervals of one foot was ridged or corrugated with one-fourth inch channels extending up and into the flume. The metal lining on the bottom was bent down and over the edge and up on the glass side, constituting a channel for the reception of the edge of the glass side. The channel was one-half inch wide and three-quarters inch deep.

As to be implied from the name, the ell is an elbow to divert the direction of soil column from the vertical. It penetrates six inches within the tank and a few inches within the flume proper. This unit was built of galvanized iron, having a cross-sectional area of 100 square inches. The bottom end of the ell is closed with a piece of extremely fine meshed brass-wire gauze, soldered thereto. The angle is of sufficient amplitude so as to change the direction of the soil column from the vertical upward to any specified range. An evaporation tank, 18 inches square and 12 inches deep, was constructed of galvanized iron. The tank was placed in a wooden box two inches larger all around than the object which it contained. The surplus space was filled with soil, thus insulating the tank upon the bottom and sides. Air temperatures were taken with a self-recording thermograph. Both this and the flumes were protected from sun and storm by canvas covers.

"Banking" Electricity for Universal Use

(*Continued from page 348*)

ing the transmission costs per kilowatt hour to 16 per cent of the present.

Twenty years ago, in the *American Electrician* for May, 1898, I published an article pointing out that the cheapest form of power storage was a reservoir at the top of a hill, to which water was pumped and the energy of fall utilized. Some years later the Westinghouse Company was concerned with a plant for Johannesburg, South Africa, and I suggested this method, and it was used.

But later on a much less expensive and much more simple and efficient and universally applicable method suggested itself. Hills cannot be found everywhere, and as turbine cost decreases and efficiency increases with the height of hydraulic head, hills are not often of sufficient height.

This new method can be used to make not only the big city the receiving and dis-

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Ranger, Texas, January 13, 1921

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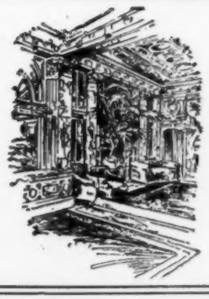

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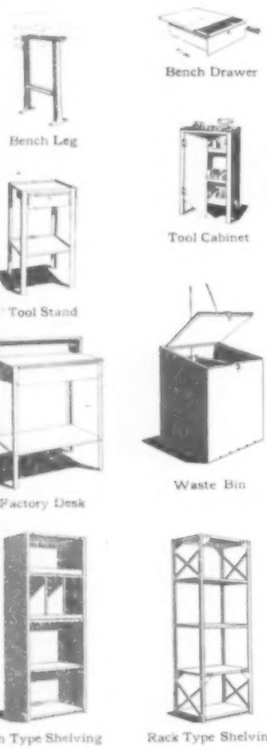

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tributing "banks," and the subreceiving and distributing "banks" each a "reception point on top of a hill," but can be applied at practically any point where power is received under the "bank" plan from the general transmission wire or distribution wires. So why not make every reception point "the top of a hill," and with a head of 1,200 or even 2,500 feet? How can this be done? By establishing a "power bank" at the point. The construction of a "power bank" is very simple. Sink a shaft at the reception point 1,200 or 2,500 feet deep, and run lateral headings into it to act as a water reservoir. Install a motor, operated from the transmission line running from the gigantic power plants at the coal mines, and connected to a rod pump, and pump the water out of the lower reservoir with the access power not being utilized (or with all the power transmitted) into another reservoir on the surface of the ground (for example, a pond or harbor), and when the power so stored in the "power bank" is needed, utilize it by driving a hydraulic turbo-generator located at the bottom of the shaft, all as shown on page 341.

Now to figure up the cost of this storage or "bank" plant. There are many mines of more than 5,000 feet depth, but we will take 2,500 as perhaps the most economical depth of shaft. With a fall of 2,500 feet each cubic yard of water flowing from the upper to the lower reservoir will generate two horsepower-hours. For a horsepower-hour is 1,980,000 foot-pounds, and a cubic yard of water weighs about 1,700 pounds, and falling 2,500 feet yields 4,250,000 foot-pounds, which is more than twice the 1,980,000 foot-pounds.

The costs of such excavation are well known, and average about $2 per cubic yard with present methods. For example, the Atlantic Mining interests mined and raised, in 1902, 446,098 tons of ore at a cost per cubic yard of $1.84, the depth of the mine being 4,250 feet, and the material, quartz. This figure is lower than that I give, but even this is not sufficiently low, for mining ore is a much more difficult thing than merely excavating. The miner has to follow a narrow vein, and cannot excavate in the most convenient direction and distance. Moreover, in excavation for a storage "bank," the best location can be picked by preliminary boring and little of the excavation need be through rock.

The volume of the shaft is what might be called dead loss excavation. But this loss is small. In the Tamarack mine, copper and 4,150 feet deep, the size of shaft, for four cages, one ladder and pipe way is 7 feet 2 inches by 27 feet 5 inches. Half this would be more than ample for the "power bank" shaft. The storage capacity being taken as 1,000,000 horsepower hours, the reservoir excavation would be 500,000 cubic yards, while the shaft excavation totals less than 10,000 cubic yards, *i.e.*, less than two per cent of the storage capacity.

Taking into account the following, *i.e.*, ability to choose best location geologically and for transportation, etc., lowering of cost due to working along standardized lines and with machinery suited for quantity production of shafts and headings, etc., for a big "power bank" system, I feel sure that the cost per cubic yard of excavation can be brought down to fifty cents. As one horsepower is stored for each one-half cubic yard, this gives the cost of storage reservoir as twenty-five cents per horsepower hour.

That this estimate of 50 cents per cubic yard cannot be much out of the way is shown by the fact that in some of the South African gold mines, it is found that the cost of blasting, excavating, breaking up, raising to surface, pulverizing, leaching, etc., amounts to almost exactly 50 cents per ton, or about $1.25 per cubic yard. The excavation alone cannot cost more than half that.

Since a pond or harbor may be used for the upper reservoir, and since the cost of motor-driven pump plus the turbine-driven generator, for the ordinary transmission system furnishing direct current for street cars, etc., differs very little from the cost of transformers, rotary converters, extra reserve capacity sizes necessary, etc., per horsepower-hour, and may even be less from saving at the generating and equipment, if direct current is used (in some cases even when alternating current is used), we can take the cost of storage plant as 25 cents per horsepower-hour.

Assuming interest at 7 per cent and depreciation at 3 per cent, both of which are high for a plant of this type, since there is very little to deteriorate, we can get cost of storage of one kilowatt-hour for one year, namely, 3 cents.

A City Without Water

(Continued from page 350)

day, and a smaller section employed on the steeper slope. As a matter of fact, however, the larger section was continued for two miles beyond the change of slope. This meant that the depth of water need be only 5 feet instead of 7¼. The result was that all through the 9-mile cut, which was deep and therefore expensive, the level of the invert, as the aqueduct floor is termed, was put about 10 inches higher than would otherwise have been possible. The extra cost for the two miles of larger section was not considerable. An advantage that may become of value in the very near future, to judge by the rate at which the city grows, consists in the fact that in this, the most expensive, section of the whole 100 miles of aqueduct, there is already a long line of conduit capable of passing 144,000,000 gallons per day. A second aqueduct is contemplated, which will carry additional water and will extend from the end of this large construction on to the vicinity of Winnipeg. The aqueduct would then be run, at the Indian Bay end, under a small head—from 0 to 4 feet, a booster pumping plant being employed to produce it.

The aqueduct from the end of the 9-mile cut follows a route determined principally by the criterion of cost. The land is so flat that topography played only a small part in the settlement of the precise route. Foundation costs and grades had to be considered, as they controlled in a large measure the expense. It is said that an aqueduct could have been run on almost any straight line connecting Shoal Lake and Winnipeg. But, by taking advantage of this condition and that, and modifying the alinement in conformity, a route was determined which effected a saving of some millions of dollars, although as a matter of fact the departures from a perfectly straight line have added several miles to the length.

While the Winnipeg Aqueduct is uniformly a concrete pipe line and does not exhibit quite that multiplicity of construction types presented by the Catskill conduit, still there were problems of importance which had to be solved. One of these concerned the foundations. It will readily be understood that a route 100 miles long would likely present great variations in connection with the supporting power of the soils encountered. As a matter of fact, the range of variation extended from peat to rock. There were soupy clay, waxy clay, various mixtures of sand and clay, granite, trap rock. The sand-clay mixtures were some of them dry, some wet. Since the level of the invert along the aqueduct line was everywhere below ground-water level, two matters were more or less urgent a large part of the time and one of them all the time. The specifications required that the concrete be laid in the dry. This requirement was met by drains and pumps. The second matter, which was urgent at times, was the necessity of providing adequate supporting power. Soupy clay, for example, had to have its resistance to weight increased. This quicksand had to be dealt

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with, a layer of stone and gravel was put in the bottom of the trench, which naturally had to be excavated deeper than would otherwise have been the case, in order to provide the necessary space. Peat beds would be dug out, and sand and gravel, if necessary, put in at the bottom of the trench. Where flowing clay was encountered, the trench was made wider and in some instances a pile foundation put in.

Near the Indian Bay end, the aqueduct parallels Snake Lake for perhaps two miles. It was unsuitable to use a porous foundation in this region and at several other points. The general reason was this: The surface waters stand at higher levels than the aqueduct structure itself.

As concrete is not especially heavy, the specific gravity being round 2, and as the bore occupies a large part of the standard cross-section, an empty aqueduct combined with a porous foundation might very well result in actual flotation. One cure for this condition is weight. Piling on excavated material is a natural solution of the problem; but here the material available for weighting was generally of a peaty character and therefore light in weight. To bring other material to the spot would have been very expensive and to pile up light material to a proper level would have meant a large amount of such material. It was eventually decided to put in a very heavy invert. This naturally meant expense as the aqueduct is 10¾ feet wide inside. Where to use a heavy invert and where not to use it was continually a matter calling for the exercise of just judgment. That success has been attained is suggested by the fact that, after a year's operation and with the conduit frequently with a very moderate amount of water in it, the structure remains secure in its place, despite the fact that it has been continually altogether submerged.

The aqueduct is of concrete throughout. But in the Red River Valley there is a siphon. This is of concrete, but the conduit is here under pressure. The pipe is reinforced and the concrete itself is especially rich in cement. The easterly section, four miles long, of this great siphon is an 8-foot pipe with an 8-inch wall.

It was entirely built on the premises, an invert being first poured and then the superstructure. The backfill over this pipe is 6 feet deep, being considerably deeper than normal. The reason centers on the prevention of a freezing temperature inside the conduit. This prevention is considered more than ordinarily desirable because the entire circuit of the inner surface is wet; whereas, with the standard section of the aqueduct, the upper part within is never wet by the flowing water.

The section of aqueduct between Red River margin and the site selected for the reservoir some 10 or 11 miles from Winnipeg is also a pipe line of circular section. It was constructed, however, of pre-cast sections 8 feet long. These sections are 5½ feet in diameter and have an 8-inch wall.

The siphon passes through strata originally laid down beneath sea water. They contain, in consequence, a heavy impregnation of sodium, magnesium, calcium and other salts. It would be undesirable, to say the least, to have any long continued reactions between these salts and the reinforced concrete immersed in ground water. A good deal of permanent drainage was therefore provided.

The manufacture of the 6½-foot pipe in 8-foot lengths was serious business. A yard was laid out at a point about a mile north of the line of the aqueduct, where it was convenient to receive steel reinforcement and cement by rail. Eight concrete mixers were installed and produced enough concrete for the manufacture of about 240 lineal feet of conduit per day. The reinforcing mesh is said to have been the heaviest ever made. It came in a 46-inch width and had to be bent to shape on the spot. This was done by using special rolling mills. Square section rods twisted were also used as reinforcement. These were likewise bent to shape in the yard. Steel forms were employed in the casting of the concrete. Steam could be admitted to and about the forms.

The actual crossing of the Red River has been accomplished by the use of cast-iron pipe 5 feet in diameter for the vertical arms of the U and by the construction of a concrete-lined tunnel for the horizontal connection from arm to arm.

Mechanical Hired Men

(*Continued from page 351*)

special feed racks. They are shunted directly under the silo chutes or into the hay or grain barns, loaded with feed and hauled into the different cattle lots. Each car is arranged so that the cattle can eat directly from the car. This eliminates much extra work in handling the feed. When the car is empty it is hauled from the cattle lot by the locomotive and replaced by another car loaded with feed. All these arrangements were worked out and installed by Mr. Lewis. They are unique on his ranch and are found on no other farm or ranch in the world.

As an auxiliary to the steam locomotive, Mr. Lewis has devised an original gasoline locomotive which he constructed out of an old 60-horsepower automobile engine. He has installed this engine on a steel frame and mounted it on four ordinary railroad wheels so that it is adapted for use on a standard gage track. It is available as an emergency engine whenever the steam engine is out of commission or when an immediate call must be answered at a time when steam is dead in the larger locomotive. This rancher has converted one of the flat cars into an automatic dump car for hauling manure and other farm refuse. The car is equipped with a special rack which can be elevated and dumped mechanically at the will of the operator.

Another flat car has been transformed into a portable disinfecting and whitewashing outfit. A large wooden tank of 35 barrels' capacity has been placed on the car. A 4-horsepower gasoline engine located at the front end of the car furnishes power to run a number of agitator paddles in the interior of the tank which stir and mix the solution. The engine also operates a triplex spray pump which is used for sprinkling disinfectant over the hogs or for spraying the hoghouses with either whitewash or disinfectant solution. All these mechanical appliances of home design are practical and efficient and are of great value in minimizing hand labor associated with routine ranch work.

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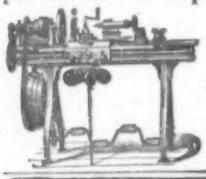

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FATHER DUFFY'S STORY. By Francis P. Duffy. New York: George H. Doran Company. 8vo.; 381 pp.

Over the top with his men!—that was one way in which this chaplain endeared himself to the boys of the Fighting Sixty-Ninth. His innate sympathy quickening his gaze, Father Duffy sees through the war-toughened exteriors, straight to the heart: the story may in fact be said to embody the humor that in men of courage lightens the most miserable environment, and the different expressions of that courage in the high adventures of war. Father Duffy does not need to wear his three medals; the memory of his cheerful self-sacrifice will be ever green among those to whom he ministered. An historical appendix by Joyce Kilmer and lists of citations and engagements close an inspiring narrative.

FUNDAMENTAL PRINCIPLES OF ELECTRIC AND MAGNETIC CIRCUITS. By Fred Alan Fish, M.E. in E.E. New York: McGraw-Hill Book Company, 1920. 8vo.; 194 pp.; illustrated.

Professor Fish's new text for undergraduate students contains many desirable features necessary to introductory study of the principles involved in electric power machinery and transmission. The lessons include electrostatics, sine wave alternating currents, non-harmonic waves, and polyphase currents, with the vital points strongly brought out. Without being so deep or so inclusive as a graduate text, it leads naturally to class discussion of more advanced details, and spurs the student to constructive thought.

THE DEVELOPMENT OF INSTITUTIONS UNDER IRRIGATION. With Special Reference to Early Utah Conditions. By George Thomas, A.B., Ph.D. New York: The Macmillan Company, 1920. 8vo.; 293 pp.; 2 illustrations.

The Mormons, entering the Great Salt Lake Valley, were confronted by the necessity for irrigation on a large scale. Individual effort was of limited use, and Professor Thomas's absorbing story deals chiefly with the way in which they developed institutions to deal with the situation. He permits original sources to recount their own experiences, and successes and failures are impartially chronicled. Valuable lessons are imparted, and the writer's own field work is liberally drawn upon; his treatise may be unreservedly commended to the attention of all students of reclamation.

LOGARITHMIC AND TRIGONOMETRIC TABLES. By Earle Raymond Hedrick. New York: The Macmillan Company, 1920. 8vo.; 143 pp.; illustrated.

The reliability and usefulness of these tables has been strikingly demonstrated since their appearance in 1913. This revised edition contains much new material. Attention may be directed to the extended treatment of hyperbolic functions, which progress in electrical engineering has made increasingly important. The demands of navigation have been recognized in the table of haversines; while business and insurance will be benefited by several tabulations involving compound interest, annuities, depreciation, etc.

THE CHICAGO DAILY NEWS ALMANAC AND YEAR-BOOK. 1920. Edited by James Langland, M.A. Chicago: The Chicago Daily News Company. 8vo.; 1023 pp.; illustrated.

If there is anything you would ask about Chicago, the last 200 pages of this splendid Year-Book probably hold the answer. The other three-fourths of the space teems with facts and figures of every conceivable activity within our own country, as well as with world-wide interests. Politics, industry, aviation, war history, government, finance, social and educational affairs, each has been put through the separator until the cream of the matter emerges. Science is well represented; the astronomical section with its charts and tables is very thorough. The Peace Conference and the League are given much space, and the Covenant appears in full.

THE PRACTICE OF LUBRICATION. By T. C. Thomsen, B.Sc. New York and London: McGraw-Hill Book Company, 1920. 8vo.; 607 pp.; illustrated.

A lubricating engineer who has been responsibly connected with large oil firms has put the lore of his experience into this volume. It is an engineering treatise on the origin, nature, and testing of lubricants, their selection, application and use. Lubrication is rapidly becoming a science, and the lubricating engineer is coming into his kingdom. He will find this book an open sesame to the knowledge demanded of the new profession, enabling him to coöperate with the laboratory, to judge a plant's mechanical and operating conditions, and to recommend the right grade of oil. Firms must establish an adequate technical service and modern sales methods, and must sell experience and knowledge with their oils. Engineers, engine builders, manufacturers and the consumer will all benefit largely by the treatise.

A TEXT-BOOK OF ORGANIC CHEMISTRY. By E. De Barry Barnett, B.Sc. Philadelphia: P. Blakiston's Son and Company, 1920. 8vo.; 380 pp.; 15 illustrations.

This general survey of the more significant classes of organic compounds is a worthy companion volume to the author's "Preparation of Organic Compounds." Into the first chapter are gathered general theories, with a few pointed words on classification, nomenclature and literature. Discussion is under the usual divisions of aliphatic and aromatic compounds, and stresses group reactions over the reactions of individual compounds.

MANUAL OF TROPICAL AND SUBTROPICAL FRUITS. By Wilson Popenoe. New York: The Macmillan Company, 1920. 8vo.; 474 pp.; illustrated.

Those for whom the warmer, more generous soils have a spell like that of the sea for the sailor will revel in the vistas opened by this book. The cocoanut, banana, pineapple, olive and fig have long been remuneratively exploited, and are omitted from this account, but rich prospects remain practically unworked. Traveling as explorer for the Department of Agriculture, Mr. Popenoe's opportunities for observation have been exceptional. In the first work of its kind in English, he provides us with a fund of knowledge—botanical, historical, and cultural—dealing with the nourishing avocado, the fragrant mango, the delicious annonas, the loquat, cousin of the apple and the pear, and so through a tantalizing list that should tempt far-seeing pioneers to develop these palatable foods and bring them to the door of the consumer.

ELGIE'S WEATHER BOOK. For the General Reader. By Joseph H. Elgie. New York: Wireless Press Inc., 1920. 12mo.; 251 pp.; illustrated.

A nature-lover here treats of weather in a familiar, colorful way. It is the romance of changing tints, striking sunsets, and storm magic. But with this poetic outlook is combined the more scientific aspects: reading the weather map is made an agreeable occupation; halos are explained, and the behavior of our animal weather-prophets is delightfully chronicled. Artistic photographs, original drawings, and a full vocabulary complete the attractive work.

CURRENCIES AFTER THE WAR. Compiled under the auspices of the International Secretariat of the League of Nations. London: Harrison and Sons, Ltd. 8vo.; 254 pp.

Disorganized currencies mean difficult economic problems, and the International Secretariat performs a distinct service in placing this survey of conditions in various countries before thoughtful readers. The immediate purpose of the survey was to give the Assembly of the League dependable material as a basis for discussion. Financiers and economists of different nationalities have given generously of their time; the result is an objective statement of facts on which to base future policy, and government officials and financiers cannot afford to overlook the wide knowledge thus placed at their disposal.

HIGH FREQUENCY APPARATUS. By Thomas Stanley Curtis. New York: Norman W. Henley Publishing Company, 1920. 12mo.; 269 pp.; illustrated.

Revised and enlarged, this treatise on design, construction and practical application makes a strong appeal to engineers, electricians, physicians, students and experimenters. The principles of the transformer, condenser, spark gap, and oscillation transformer are set forth, and the construction of small and large outfits detailed; a section is devoted to electro-therapeutic and X-ray apparatus, and another to apparatus for the cultivation of plants and vegetables.

ENGLAND BLUE GUIDE. Edited by Findlay Muirhead, M.A., F.R.G.S. New York and London: The Macmillan Company, 1920. 8vo.; illustrated.

Before the war, Professor Muirhead wrote Baedeker's "Great Britain," an almost perfect travelers' guide. The SCIENTIFIC AMERICAN of November 2, 1918, revealed how the Baedeker series was clandestinely used by Germany in acquiring information for the General Staff, thus discrediting the books for American and English use. We are glad to see this new guide by the same qualified compiler; it is on the whole a most satisfactory achievement. If now and again the maps are slightly inferior to Baedeker's, the "Practical Information," which even includes aviation passenger routes and rates, can scarcely be improved upon, while much more detailed attention is given to literary shrines, and the descriptions of cathedrals and abbeys are accompanied by admirable plans. Prof. G. Baldwin Brown's "Introduction to the study of English Monuments" is a noteworthy contribution. The routes given by the Blue Guide are excellent, but do not embrace Wales or Scotland, an omission we trust may be corrected by a small, inexpensive supplementary volume.

GYPSUM DEPOSITS OF THE UNITED STATES. By R. W. Stone and others. Washington: Government Printing Office, 1920. 8vo.; 326 pp.; illustrated.

This report supersedes the Geological Survey's Bulletin No. 223 of the same title. In fourteen years, output has increased 300 per cent. Analyses, production, imports and technology are presented, and the various deposits are mapped and described at great length.

THE GRAND STRATEGY OF EVOLUTION. By William Patten, Ph.D. Boston: Richard G. Badger, 1920. 8vo.; 430 pp.

From close observation of nature's processes Professor Patten seeks to form a conception of "rightness" acceptable to all who follow his thought. He cites the philosophy of war, to condemn it: he minutely scrutinizes the ethics and morality of evolution, the basic factors in constructive action, and individuality; he passes to nature's system of self-administration and self-control, and to the "architonics" of evolution, of mentality, and of social growth. It is a large-visioned, biological philosophy that bears witness to truths which should more strongly influence human conduct.

LEAD. Including Lead Pigments and the Desilverization of Lead. By J. A. Smythe, Ph.D., D.Sc. New York: Isaac Pitman and Sons. 12mo.; 120 pp.; illustrated.

This little volume of the Common Commodities and Industries series straightforwardly outlines processes used, from the uncovering of the ore to the marketing of the metal and the pigments derived from it. Smelting, purification, and conversion into red and white lead are closely followed, furnace methods are sketched, and the historical and human aspects of the subject are emphasized in the plainest of language.

HAND BOOK OF NATURAL GAS. By Henry P. Westcott. Erie, Pa.: Metric Metal Works, 1920. 8vo.; 725 pp.; illustrated.

A more compact and complete body of information, in one handy volume, could scarcely be asked for. This third edition eliminates some obsolete material, corrects a few errors that crept into former editions, and takes up not a few entirely new topics. Geology, properties, field work, well measurement, pipe lines, distribution, domestic consumption, industrial consumption and instalment, and many other headings appear, including helium and its practical uses. From whatever angle the reader may be interested in natural gas, this treatise offers him authentic information of the greatest value.

TECHNIQUE OF PRACTICAL DRAWING. For Teachers, Students and Professional Artists. By Edward S. Pilsworth. New York: The Macmillan Company, 1920. 8vo.; 150 pp.; 23 plates.

The advertising pages of any magazine will furnish instances of good ideas spoiled by poor technique. Few of the cheaper handbooks on this subject are worth anything, but Mr. Pilsworth gives us an exceptional guide to the production of professional work in pencil, pen and brush. The tools, outlining, shading, and mixed techniques are handled with masterful brevity, modifications due to reproductive processes are taken into consideration, and attractive plates convey their lessons so plainly that the accompanying comments are well-nigh unnecessary.

CLOTHING. Choice, Care, Cost. By Mary Schenck Woolman, B.S. Philadelphia: J. B. Lippincott Company, 1920. 8vo.; 289 pp.

The budget plan is gradually gaining ground among consumers, and a most important item of the list is clothing. Here is a book that thoroughly posts its readers, telling them how to judge the quality of textiles by sight and touch, and how, at reasonable cost, to clothe themselves in tasteful and durable raiment. It acquaints the reader with the values—in money, wear and looks—of staple materials; with care, repair, renovation, laundering and dyeing. While the ultimate consumer will perhaps profit most by Mrs. Woolman's instruction, sales people, buyers and advertisers, extension workers and teachers of home economics may all benefit by putting these facts and suggestions to work.

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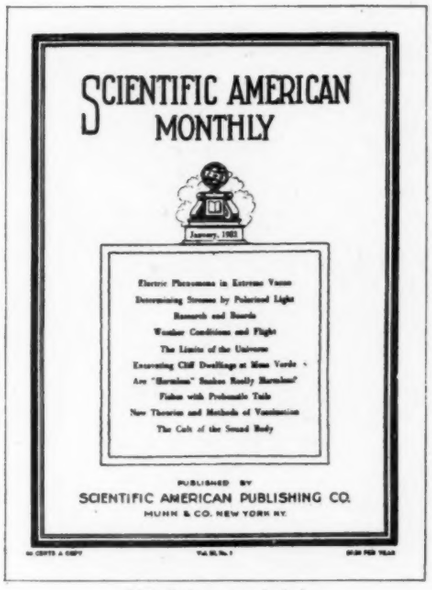

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Progress in Mechanical Engineering
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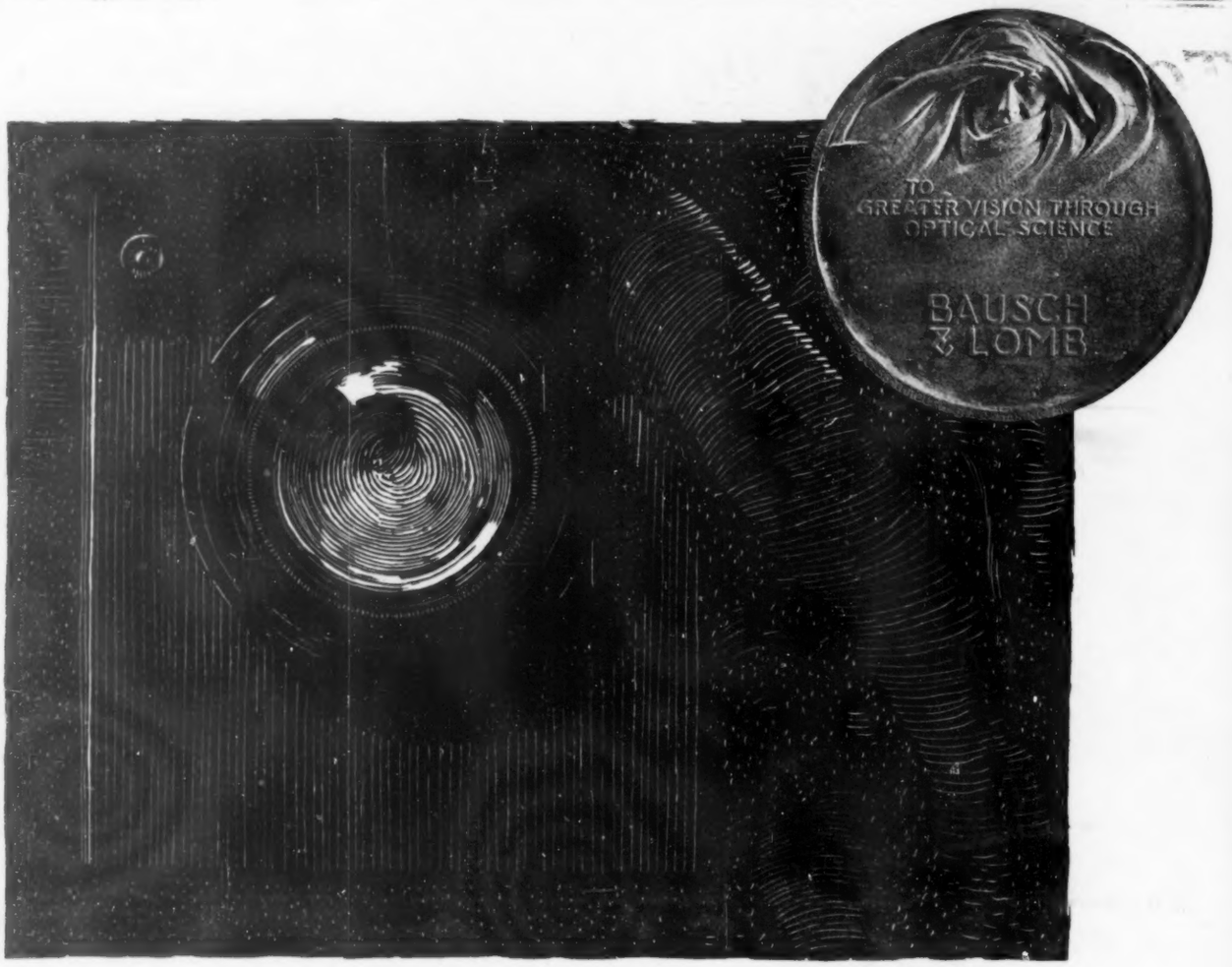

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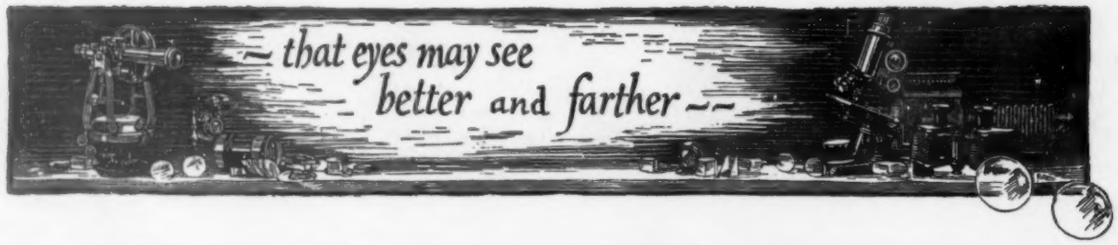
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